CONTROL MEASURE EVALUATIONS PREPARED FOR SOUTHEAST PENNSYLVANIA OZONE STAKEHOLDERS GROUP

DRAFT REPORT

Air Quality Program Development Support to Pennsylvania Department of Transportation

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Emissions and Control Measure Summary Tables

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Southeast Pennsylvania Ozone
Stakeholders Meeting

E.H. Pechan & Associates, Inc.
Springfield, VA 22151

Ozone Season Daily Emission Estimates for the Five Counties in Pennsylvania in the Philadelphia Nonattainment Area (short tons per day)

Source Category	1990	1996	2005	1990	1996	2005
	Volatile Organic Compounds			Oxides of Nitrogen		
FUEL COMB. ELEC. UTIL.	**0.92**	**1.24**	**1.47**	**63.40**	**69.16**	**37.52**
Coal	0.13	0.21	0.25	28.62	27.62	10.76
Oil	0.45	0.66	0.79	25.65	33.19	17.14
Gas	0.01	0.01	0.01	4.76	5.30	6.10
Internal Combustion	0.33	0.37	0.42	4.37	3.06	3.52
FUEL COMB. INDUSTRIAL	**0.87**	**0.89**	**0.95**	**86.83**	**56.84**	**55.97**
Coal	0.05	0.06	0.07	14.95	14.31	13.65
Oil	0.04	0.04	0.04	10.28	5.90	5.78
Gas	0.29	0.26	0.26	43.10	23.96	22.53
Other	0.00	0.00	0.00	1.07	0.99	0.94
Internal Combustion	0.48	0.52	0.59	17.44	11.67	13.08
FUEL COMB. OTHER	**1.03**	**1.05**	**1.08**	**26.82**	**25.55**	**26.61**
Commercial/Institutional Coal				0.78	0.52	0.63
Commercial/Institutional Oil	0.32	0.33	0.33	10.86	10.08	10.38
Commercial/Institutional Gas	0.65	0.67	0.69	13.59	13.61	14.21
Misc. Fuel Comb. (Except Residential)	0.05	0.05	0.05	0.72	0.45	0.48
Residential Other	0.00	0.00	0.00	0.86	0.88	0.91
CHEMICAL & ALLIED PRODUCT MFG	**14.80**	**11.59**	**12.44**	**0.09**	**0.06**	**0.06**
Organic Chemicals	8.78	5.82	6.25			
Inorganic Chemicals	0.13	0.13	0.13	0.08	0.05	0.05
Polymers & Resins	0.67	0.64	0.69	0.01	0.01	0.02
Paints, Varnishs, Lacquers, Enamels	1.58	1.28	1.37			
Pharmaceuticals	0.85	0.84	0.90			
Other Chemicals	2.79	2.88	3.10			
METALS PROCESSING	**0.62**	**0.55**	**0.52**	**1.47**	**0.91**	**0.95**
Non-Ferrous Metals Processing	0.15	0.13	0.14	0.00	0.00	0.00
Ferrous Metals Processing	0.47	0.42	0.39	1.46	0.90	0.95
PETROLEUM & RELATED INDUSTRIES	**21.53**	**19.61**	**11.35**	**9.95**	**6.01**	**6.11**
Petroleum Refineries & Related Industries	21.23	19.29	11.01	9.79	5.83	5.92
Asphalt Manufacturing	0.30	0.32	0.34	0.16	0.18	0.20
OTHER INDUSTRIAL PROCESSES	**2.31**	**2.17**	**2.32**	**2.79**	**2.11**	**2.23**
Agriculture, Food, & Kindred Products	1.53	1.31	1.35	0.02	0.02	0.02
Wood, Pulp & Paper, & Publishing Products	0.07	0.07	0.08			
Rubber & Miscellaneous Plastic Products	0.61	0.69	0.79			
Mineral Products	0.04	0.04	0.04	2.77	2.09	2.21
Machinery Products	0.06	0.06	0.06	0.00	0.00	0.00
Miscellaneous Industrial Processes	0.00	0.00	0.00			
SOLVENT UTILIZATION	**223.41**	**207.99**	**193.75**	**0.03**	**0.04**	**0.04**
Degreasing	15.94	15.23	14.81			
Graphic Arts	20.65	20.99	21.98			
Dry Cleaning	0.77	0.77	0.78			
Surface Coating	147.45	131.52	123.05	0.03	0.03	0.03
Other Industrial	3.16	3.26	3.53	0.00	0.00	0.00
Nonindustrial	35.45	36.22	29.60			

Ozone Season Daily Emission Estimates for the Five Counties in Pennsylvania in the Philadelphia Nonattainment Area (short tons per day)

	1990	1996	2005	1990	1996	2005
Source Category	**Volatile Organic Compounds**			**Oxides of Nitrogen**		
STORAGE & TRANSPORT	**46.22**	**31.84**	**22.39**	**0.00**	**0.00**	**0.00**
Bulk Terminals & Plants	0.65	0.66	0.73			
Petroleum & Petroleum Product Storage	4.73	4.71	3.00			
Petroleum & Petroleum Product Transport	14.43	13.84	6.02			
Service Stations: Stage I	4.19	4.61	5.07			
Service Stations: Stage II	19.57	5.18	4.50			
Service Stations: Breathing & Emptying	1.67	1.84	2.02			
Organic Chemical Storage	0.39	0.41	0.45			
Organic Chemical Transport	0.59	0.58	0.59			
WASTE DISPOSAL & RECYCLING	**22.05**	**13.08**	**13.47**	**1.69**	**1.73**	**1.79**
Incineration	1.59	1.63	1.68	1.63	1.67	1.72
Open Burning	0.22	0.23	0.23	0.06	0.06	0.07
POTW	7.78	7.95	8.19			
TSDF	12.30	3.12	3.21			
Landfills	0.16	0.16	0.16			
HIGHWAY VEHICLES	**187.89**	**139.22**	**66.63**	**158.31**	**149.63**	**105.82**
Light-Duty Gas Vehicles & Motorcycles	167.67	123.87	58.95	122.89	119.16	84.66
Light-Duty Gas Trucks	14.75	10.74	4.10	12.42	11.94	7.89
Heavy-Duty Gas Vehicles	2.45	1.45	0.82	2.24	2.26	1.95
Diesels	3.04	3.17	2.75	20.76	16.27	11.32
OFF-HIGHWAY	**88.05**	**88.40**	**67.88**	**99.48**	**100.21**	**93.84**
Non-Road Gasoline	69.89	69.07	47.55	9.02	9.01	22.04
Non-Road Diesel	9.83	9.97	10.09	66.72	68.23	52.93
Aircraft	7.19	8.37	9.42	8.16	9.51	10.70
Railroads	1.15	0.99	0.83	15.57	13.46	8.19
MISCELLANEOUS	**2.31**	**2.31**	**2.31**	**0.29**	**0.29**	**0.29**
Other Combustion	2.31	2.31	2.31	0.29	0.29	0.29
TOTAL	**612**	**520**	**397**	**451**	**413**	**331**

Southeast Pennsylvania Ozone Stakeholders
Control Measures and Emission Reductions

Measure Number	Description	VOC (tpd)		NO_x (tpd)	
		Credit	Total	Credit	Total
2005 CAA Baseline Emission Estimate			397		331
3	Autobody Refinishing - South Coast AQMD Limits	3.8	3.8	0	0
4	Surface Cleaning and Degreasing	5.9	9.7	0	0
5	Service Stations - PV Valves	1.9	11.6	0	0
13	Phase III of NO_x MOU	0	11.6	8.3	8.3
	Utility Boilers			6.4	
	Industrial Boilers			~~1.7~~	
	Refinery Heaters			~~0.3~~	
14	Industrial Boiler Oil/Gas - LNB (100-250 mmBtu/hr)	0	11.6	3.5 to 4.5	12.3
22	Reciprocating IC Engines (> ~~1,800~~ hp controlled) (1,000 hp)	0	11.6	8.5 to 10.5	~~21.8~~ 23
23	Process Heaters Gas - LNB (100-250 mmBtu/hr)	0	11.6	4.4 to 8.2	28.1
36	More Remote Sensing	1.2	12.8	0.6	28.7
42a	SEPTA's Clean Diesel Program (400 Icarus Buses)	0.5	13.3	2.2	30.9
70	Park and Ride Lot Expansion	0.03	13.3	0.04	30.9
51	Rail Headway Improvements	0.04	13.4	0.06	31.0
55	Improvements to Suburban Bus Service	0.07	13.4	0.10	31.1
76	National LEV	11.5	24.9	13.5	44.6
96	LPG Pilot Program	2.4	27.3	1.4	46.0
34	Land Use Planning - Promote Community Centers	1.1	28.4	1.0	47.0
109	Airport Emission Controls (GSE plus shuttles)	0.2	28.6	0.07	47.1
116	Ban Lawn and Garden on Ozone Action Days	11.2	39.8	0.4	47.5

Southeast Pennsylvania Ozone Stakeholders
Voluntary Measures

Measure Number	Description	VOC (tpd)		NO_x (tpd)	
		Credit	Total	Credit	Total
Mobility Alternatives					
61	Comprehensive Regional Ride Sharing	0.3	0.3	0.33	0.33
62	Transit Chek	0.12	0.42	0.14	0.47
63	Telecommuting	0.59	1.01	0.68	1.15
64	Alternative Work Schedules	0.21	1.22	0.27	1.42
Educational Programs					
122	School Based Public Awareness	4.6	5.82	7.8	9.22
123	We Care Programs Promotion				
124	Outreach and Education				
Ozone Action Program					
129	Transit Strategies	1.4	7.22	2.5	11.72
118	Voluntary No Drive Days	5.1	12.32	7.4	19.12
113	Voluntary No Burn Days	0.18	12.5	0.08	19.2
Bicycle Promotion and Improvement					
71,72,73	Work/Rail/Non-work Trips	0.54	13.0	0.52	19.7

Philadelphia Source Category Summaries

Non Affected by OTC MOU

Process Heaters - LNB Control

Source Size (MMBtu/hr)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	21.04			
All Sources	10.42	49.5%	3,374,712	887
250+	0.34	1.6%	173,341	1,397
100-250	4.45	21.2%	1,497,980	922
<100	1.82	8.7%	934,561	1,407
0	3.80	18.1%	768,830	554

ICI Boilers - LNB Control

Source Size (MMBtu/hr)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	15.07			
All Sources	7.53	50.0%	1,283,791	467
250+	2.02	13.4%	412,299	559
100-250	3.51	23.3%	395,274	309
<100	1.01	6.7%	235,715	639
0	1.00	6.6%	240,503	659

IC Engines - Low Emission Combustion

Source Size (MMBtu/hr)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	14.38			
All Sources	12.14	84.4%	1,997,219	451
2,500+	2.48	17.2%	543,280	600
1,800-2,500	6.73	46.8%	1,139,380	464
1,000-1,800	1.76	12.2%	310,540	483
<1,000	0.15	1.0%	54,174	989
0	1.02	7.1%	55,483	149

Notes:

* Uncontrolled emissions represent current control emissions based on State data.
* Cost-Effectiveness assumes daily emission reduction * 365 days.
* *Source size of 0 represents records with missing size data. Default cost-per-tons values used.*

Philadelphia Source Category Summaries
Non Affected by OTC MOU

Process Heaters - LNB+FGR Control

Source Size (MMBtu/hr)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	21.04			
All Sources	11.43	54.3%	5,285,582	1,267
250+	0.38	1.8%	238,668	1,721
100-250	4.88	23.2%	2,158,044	1,212
<100	1.99	9.5%	1,669,667	2,299
0	4.18	19.9%	1,219,203	799

ICI Boilers - LNB+FGR Control

Source Size (MMBtu/hr)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	15.07			
All Sources	9.04	60.0%	4,898,520	1,485
250+	2.42	16.1%	1,153,757	1,306
100-250	4.22	28.0%	1,720,614	1,117
<100	1.21	8.0%	1,524,893	3,453
0	1.20	8.0%	499,256	1,140

IC Engines - NSCR Control

Source Size (hp)	1990 NOx Emission Reduction (tpd)	% Red Of Total	Annual Control Cost ($)	Estimated Cost-Effectiveness ($/ton)
Uncontrolled Emissions	14.38			
All Sources	12.88	89.6%	2,640,070	562
2,500+	2.56	17.8%	475,561	509
1,800-2,500	6.96	48.4%	1,363,120	537
1,000-1,800	1.82	12.7%	482,330	726
<1,000	0.16	1.1%	156,404	2,678
0	1.37	9.5%	161,765	323

Notes:
* Uncontrolled emissions represent current control emissions based on State data.
* Cost-Effectiveness assumes daily emission reduction * 365 days.
* Source size of 0 represents records with missing size data. Default cost-per-tons values used.

Philadelpl[illegible] ICI Boilers
LNB Controlled - Non-Affected by OTC MOU

FIPS County	Plant Name	Plant ID	Point ID	Rated Capacity (MMBtu/hr)	1990 Daily NOx	1990 Daily Controlled NOx	1990 Annual NOx	1990 Annual Controlled NOx	1993 Annual NOx	1994 Annual NOx	1995 Annual NOx	Annual LNB Control Cost (1990$)	Assumed Operating Days Per Year	Cost Per Ton Reduced ($/ton)
017	ROHM & HAAS DELAWARE VALLEY, INC	0009	031	142 0	0 0000	0.0000	14.2	7 1	9.1	30 3	6.7	22,722	73	3,200
017	ROHM & HAAS DELAWARE VALLEY, INC	0009	032	137 0	0.0672	0.0336	15 6	7 8	44 8	32 3	57.6	21,747	137	2,788
017	ROHM & HAAS DELAWARE VALLEY, INC	0009	033	137 0	0 3653	0.1827	43.3	21.7	54 5	34 0	55.4	21,747	97	1,004
017	ROHM & HAAS DELAWARE VALLEY, INC	0009	038	142 0	0.0000	0.0000	15 3	7.7	17 9	31 2	1 8	22,722	69	2,970
017	MINNESOTA MINING & MANUFACTURING CO	0056	031	60 0	0.0402	0 0201	7.3	3 7	7 6	4.2	10 3	7,916	112	2,169
017	MINNESOTA MINING & MANUFACTURING CO	0056	032	75 0	0.0372	0.0186	8 6	4 3	5 8	11.3	9 0	10,403	223	2,419
029	SONOCO PRODUCTS CO., DWNGTWN PAPR D	0015	031	105.0	0.1083	0.0542	1.3	0 7	0.0	0.0	0 0	15,703	12	24,158
029	SONOCO PRODUCTS CO., DWNGTWN PAPR D	0015	032	197.0	[illegible]	[illegible]	352.4	176.2	298.3	321.6	385.0	[illegible]	334	1,389
029	WYETH - AYERST LABORATORIES, INC	0029	031	62.7	0.1689	0.0845	42.9	21.5				8,355	254	390
029	WYETH - AYERST LABORATORIES, INC	0029	034	59.0	0.0963	0.0482	15 7	7.9	9 0			7,755	163	988
045	WITCO CHEMICAL CORP.	0002	031	76 5	0.0617	0.0309	5.8	2 9	3.2	0 9	14.7	10,658	94	3,675
045	WITCO CHEMICAL CORP	0002	033	94.0	0.0634	0.0317	18.3	9 2	19 4	19.0	5.9	13,714	260	1,499
045	SCOTT PAPER CO.	0016	033	198.0	1.2874	0.6437	80.0	40 0	0 9	25 9	17.3	34,133	111	853
045	SUN REFINING & MARKETING CO.	0025	099	169.8	0.4383	0.2192	163.8	81.9	221 6	122 9	122.7	28,281	363	345
045	BOEING HELICOPTER COMPANY	0029	035	86.0	0.0000	0.0000	20.1	10 1	15 3	21.9	27 8	12,299	105	1,224
045	BOEING HELICOPTER COMPANY	0029	036	86 0	0.1282	0.0641	10 9	5.5	36 9	21.6	21.1	12,299	85	2,257
045	CONGOLEUM CORP	0049	031	60 0	0.0000	0.0000	21.6	10 8				7,916	38	733
091	CABOT CORP., DIV. OF KBI	0009	032	50 3	0 0353	0.0177	13.5	6 8	0 0	18 3	16 8	6,379	323	945
091	CABOT CORP., DIV OF KBI	0009	033	62 9	0.0000	0 0000	0.7	0.4	16.5	12.6	8 2	8,386	15	23,960
091	MERCK SHARP & DOHME	0028	033	109.4	0.0945	0.0473	16.0	8.0	6.7	19.2	8.0	16,512	181	2,064
091	MERCK SHARP & DOHME	0028	034	96.8	0.0444	0.0222	9.3	4 7	15.7	45.9	27.0	14,216	248	3,057
091	MERCK SHARP & DOHME	0028	035	93.2	0 0000	0.0000	37.7	18.9	50.6	31.1	10.4	13,571	140	720
091	MERCK SHARP & DOHME	0028	038	206 0	0.4258	0.2129	8 3	4.2	1 0	2 6		35,828	5	8,633
091	SIMPSON PAPER CO.	0057	032	83.4	0.1816	0.0908	46 3	23.2	25.1	24 7	26.4	11,846	255	512
091	SIMPSON PAPER CO.	0057	033	84.2	0.2081	0.1041	56.2	28.1	17 3	26.1	38.4	11,985	270	427
091	OCCIDENTAL CHEMICAL CORP.	0058	031	72.0	0.1169	0.0585	13.8	6.9	18 2	23.7	62.3	9,895	107	1,434
091	OCCIDENTAL CHEMICAL CORP.	0058	032	120.0	0.1333	0.0667	8.4	4.2	0 2	4.6	11.6	18,492	49	4,403
091	OCCIDENTAL CHEMICAL CORP.	0058	033	126 0	0.0000	0.0000	4.2	2.1	48 1	13.4	72.9	19,630	29	9,348
091	OCCIDENTAL CHEMICAL CORP.	0058	034	120.0	[illegible]	[illegible]	334.2	[illegible]	281.6	[illegible]	245.0	[illegible]	302	1,106
091	NORTH PENN HIDE CO.	0065	031	50.4	0.0545	0.0273	26.0	13.0	49.4	0.1	13.6	6,395	78	492
091	NORTH PENN HIDE CO	0065	033	50.4	0.1192	0.0596	5.5	2.8	9.2	31.8	22.3	6,395	217	2,325
091	NORTH PENN HIDE CO.	0065	034	50.4	0.1192	0.0596	52 7	26.4	2 9	26.4	13.3	6,395	217	243
091	SMITHKLINE BEECHAM PHARMACEUTICALS	0118	032	51.0	0.0431	0.0216	11.1	5.6	16 4	20 3	10.8	6,488	197	1,169
091	SMITHKLINE BEECHAM PHARMACEUTICALS	0118	033	51.0	0.0000	0.0000	9.7	4.9	4 0	24.7	10.9	6,488	170	1,338
101	SUN REFINING AND MARKETING 1 O	1501	033	169 0	0.4689	0.2345						28,118	364	330
101	SUN REFINING AND MARKETING 1 O	1501	034	169.0	0.4689	0.2345						28,118	364	330
101	SUN REFINING AND MARKETING 1 O	1501	035	203.0	0.5714	0.2855						35,191	364	338
101	CHEVRON USA INC. REFINERY	1511	037	450.0	0.9300	0.4650	342.0	171.0				93,236	274	545
101	CHEVRON USA INC. REFINERY	1511	038	450.0	0.9300	0.4650	342.0	171.0				93,236	274	545
101	CHEVRON USA INC. REFINERY	1511	039	450 0	0.9300	0.4650	342.0	171 0				93,236	274	545
101	CHEVRON USA INC. REFINERY	1511	040	600.0	1.2400	0.6200	456.0	228 0				132,591	274	582
101	GENERAL ELECTRIC CO	1521	006	102.0	0.0003	0.0002						15,156	280	541,286
101	GENERAL ELECTRIC CO	1521	007	57.0	0.0001	0.0001						7,434	154	0
101	GENERAL ELECTRIC CO	1521	008	69 0	0.0001	0.0001						9,393	210	0
101	ROHM & HAAS	1531	014	92.0	0.1675	0.0838						13,358	322	496
101	ROHM & HAAS	1531	016	92 0	0.1580	0.0790						13,358	322	525
101	ALDAN RUBBER CO	1561	001	25.0	0.0091	0.0046						2,711	187	3,607
101	CONTAINER CORP OF AMER	[illegible]	002	240.0	[illegible]	[illegible]						[illegible]	[illegible]	[illegible]
101	PROGRESS LIGHTING CO	1584	001	17.0	0.0108	0.0054						1,691	250	1,253
101	PROGRESS LIGHTING CO	1584	002	7.0	0.0124	0.0062						570	250	368
101	KURZ-HASTINGS INC	1585	001	7.0	0 0050	0.0025						570	250	912
101	PAPER MANUFACTURERS	1591	001	17.0	0.0272	0.0136						1,691	250	497
101	INTERNATIONAL PAPER CO	1596	001	4.0	0.0010	0.0006						288	317	2,271
101	G SPRUANCE CO	2062	001	5.0	0.0006	0.0003						378	87	14,483

Philadelphia Area ICI Boilers
LNB Controlled - Non-Affected by OTC MOU

FIPS County	Plant Name	Plant ID	Point ID	Rated Capacity (MMBtu/hr)	1990 Daily NOx	1990 Daily Controlled NOx	1990 Annual NOx	1990 Annual Controlled NOx	1993 Annual NOx	1994 Annual NOx	1995 Annual NOx	Annual LNB Control Cost (1990$)	Assumed Operating Days Per Year	Cost Per Ton Reduced ($/ton)
101	SKF IND.	2067	001	43.0	0.0082	0.0041						5,265	83	15,472
101	PHILADELPHIA BAKING CO. GRANT	3048	003	8.0	0.0063	0.0032						672	208	1,042
101	LAFRANCE CASTING CO	3164	004	5.0	0.0020	0.0010						378	115	3,287
101	GENERAL ELECTRIC CO	3217	001	7.0	0.0006	0.0003						570	173	10,983
101	SMITH KLINE BECKMAN	3303	012	27.0	0.0229	0.0115						2,978	255	1,024
101	SMITH KLINE BECKMAN	3303	013	27.0	0.0229	0.0115						2,978	255	1,024
101	MCWHORTER	3542	002	84.0	0.0053	0.0027						11,950	240	19,151
101	ARBILL INDUSTRIES	3811	001	5.0	0.0014	0.0007						378	65	8,308
101	ARBILL INDUSTRIES	3811	002	5.0	0.0014	0.0007						378	65	8,308
101	PHILA GAS WORKS-STA B	4922	010	7.0	0.0024	0.0012						570	364	1,305
101	PHILA GAS WORKS-STA B	4922	011	3.0	0.0007	0.0004						202	140	4,810
101	GATX ALLEGHENY AVE AND DELAWAR	5003	001	20.0	0.0082	0.0041						2,063	364	1,382
101	BP OIL CORP	5004	001	1.0	0.0001	0.0001						53	364	0
101	DIAMOND PETROLEUM	5016	005	30.0	0.0208	0.0104						3,389	364	895
101	CONTAINER RECYCLERS LTD	5112	002	10.0	0.0026	0.0013						883	87	7,807
101	U.S NAVAL BASE	9702	006	125.0	0.3267	0.1634						19,439	138	863
101	U.S NAVAL BASE	9702	007	125.0	0.5095	0.2548						19,439	204	374
101	U.S NAVAL BASE	9702	008	125.0	0.4662	0.2332						19,439	150	556
101	U.S NAVAL BASE	9702	009	125.0	0.6872	0.3436						19,439	286	198
101	U.S NAVAL BASE	9702	016	120.0	0.0938	0.0469						18,492	1	394,286
101	U.S NAVAL BASE	9702	056	6.0	0.0024	0.0012						472	130	3,026

Notes.
* Rated capacity values from Stakeholder data (Francine Carlini), AIRS/AFS (Joe White), and Philadelphia fax (Air Mgt. Services Admin.)
* Annual NOx values from Stakeholder data (Francine Carlini).
* Operating days per year calculated as operating hours/24 hr per day. Operating hours provided by Joe White and taken from AFS/AIRS.
* Cost per ton calculated with annual cost and daily NOx reduction projected to yearly reduction using operating days/year where annual emissions not available.
* Shaded cells represent coal-fired boilers

ICI Boilers - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Rated Capacity (MMBtu/hr)	1990 Daily NOx Emissions (tons)	1990 Annual NOx Emissions (tons)
017	0002	STAUFFER CHEMICAL CO.	032	NA 0.0	0.0140	0.0
017	0009	ROHM & HAAS DELAWARE VALLEY, INC.	031	142.0	0.0000	14.2
017	0009	ROHM & HAAS DELAWARE VALLEY, INC.	032	137.0	0.0672	15.6
017	0009	ROHM & HAAS DELAWARE VALLEY, INC.	033	137.0	0.3653	43.3
017	0009	ROHM & HAAS DELAWARE VALLEY, INC.	038	142.0	0.0000	15.3
017	0039	DIAL CORPORATION	031	0.0	0.0162	0.0
017	0039	DIAL CORPORATION	032	0.0	0.0800	0.0
017	0040	FASSON-DIV. OF AVERY PROD. CORP	031	0.0	0.0033	0.0
017	0040	FASSON-DIV. OF AVERY PROD. CORP	032	0.0	0.0036	0.0
017	0040	FASSON-DIV. OF AVERY PROD. CORP	033	0.0	0.0053	0.0
017	0055	UNITED STATES STEEL CORP., THE	425	0.0	0.0239	0.0
017	0056	MINNESOTA MINING & MANUFACTURING CO	031	60.0	0.0402	7.3
017	0056	MINNESOTA MINING & MANUFACTURING CO	032	75.0	0.0372	8.6
017	0058	BAKE RITE ROLLS. DIV. OF N.EAST FOO	031	0.0	0.0011	0.0
017	0058	BAKE RITE ROLLS. DIV. OF N.EAST FOO	032	0.0	0.0011	0.0
029	0003	WEST CHESTER UNIVERSITY	032	0.0	0.0152	0.0
029	0005	NVF CO.	034	0.0	0.1490	0.0
029	0009	QUEBECOR PRINTING ATGLEN, INC.	031	0.0	0.0058	0.0
029	0009	QUEBECOR PRINTING ATGLEN, INC.	032	0.0	0.0121	0.0
029	0009	QUEBECOR PRINTING ATGLEN, INC.	033	0.0	0.0003	0.0
029	0011	EMBREEVILLE CENTER	034	0.0	0.0153	0.0
029	0015	SONOCO PRODUCTS CO., DWNGTWN PAPR D	031	105.0	0.1083	1.3
029	0015	SONOCO PRODUCTS CO., DWNGTWN PAPR D	932	197.0	0.0220	0.0
029	0024	LUKENS STEEL CO.	031	0.0	0.0158	0.0
029	0024	LUKENS STEEL CO.	032	0.0	0.0151	0.0
029	0024	LUKENS STEEL CO.	033	0.0	0.0215	0.0
029	0024	LUKENS STEEL CO.	034	0.0	0.0149	0.0
029	0029	WYETH - AYERST LABORATORIES, INC.	031	62.7	0.1689	42.9
029	0029	WYETH - AYERST LABORATORIES, INC.	034	59.0	0.0963	15.7
029	0030		031	0.0	0.0167	0.0
029	0030		032	0.0	0.0165	0.0
029	0040	MONSEY PRODUCTS CO.	032	0.0	0.0080	0.0
029	0043	GRAPHIC PACKAGING CORP.	032	0.0	0.0043	0.0
029	0054	DOPACO INC.	031	0.0	0.0074	0.0
029	0056	SARTOMER C0,INC.	031	0.0	0.0126	0.0
045	0002	WITCO CHEMICAL CORP.	031	76.5	0.0617	5.8
045	0002	WITCO CHEMICAL CORP.	033	94.0	0.0634	18.3
045	0016	SCOTT PAPER CO.	033	198.0	1.2874	80.0
045	0016	SCOTT PAPER CO.	103	0.0	0.0232	0.0
045	0016	SCOTT PAPER CO.	104	0.0	0.0185	0.0
045	0016	SCOTT PAPER CO.	105	0.0	0.1193	0.0
045	0017	PQ CORP.	035	0.0	0.0050	0.0
045	0025	SUN REFINING & MARKETING CO.	099	169.8	0.4383	163.8
045	0029	BOEING HELICOPTER COMPANY	035	86.0	0.0000	20.1
045	0029	BOEING HELICOPTER COMPANY	036	86.0	0.1282	10.9
045	0029	BOEING HELICOPTER COMPANY	037	0.0	0.0858	0.0
045	0030	BP OIL, INC.	031	218.0	0.0890	0.0
045	0040	FOAMEX L.P.	031	0.0	0.0027	0.0
045	0040	FOAMEX L.P.	032	0.0	0.0027	0.0
045	0049	CONGOLEUM CORP.	031	60.0	0.0000	21.6
045	0049	CONGOLEUM CORP.	C02	0.0	0.0204	0.0
045	0049	CONGOLEUM CORP.	C03	0.0	0.0189	0.0
045	0049	CONGOLEUM CORP.	C04	0.0	0.0307	0.0
091	0008	GRATERFORD PENITENTIARY	044	0.0	0.0216	0.0
091	0009	CABOT CORP., DIV. OF KBI	032	50.3	0.0353	13.5
091	0009	CABOT CORP., DIV. OF KBI	033	62.9	0.0000	0.7
091	0028	MERCK SHARP & DOHME	032	0.0	0.1118	0.0
091	0028	MERCK SHARP & DOHME	033	109.4	0.0945	16.0
091	0028	MERCK SHARP & DOHME	034	96.8	0.0444	9.3

ICI Boilers - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Rated Capacity (MMBtu/hr)	1990 Daily NOx Emissions (tons)	1990 Annual NOx Emissions (tons)
091	0028	MERCK SHARP & DOHME	035	93.2	0.0000	37.7
091	0028	MERCK SHARP & DOHME	038	206.0	0.4258	8.3
091	0030	AMERICAN OLEAN TILE CO., INC.	031	0.0	0.0058	0.0
091	0030	AMERICAN OLEAN TILE CO., INC.	032	0.0	0.0068	0.0
091	0040	SUPERIOR TUBE CO.	031	0.0	0.0147	0.0
091	0040	SUPERIOR TUBE CO.	032	0.0	0.0344	0.0
091	0041	ROHM & HAAS CO.	031	0.0	0.0148	0.0
091	0041	ROHM & HAAS CO.	033	0.0	0.0233	0.0
091	0041	ROHM & HAAS CO.	034	0.0	0.1305	0.0
091	0057	SIMPSON PAPER CO.	032	83.4	0.1816	46.3
091	0057	SIMPSON PAPER CO.	033	84.2	0.2081	56.2
091	0058	OCCIDENTAL CHEMICAL CORP.	031	72.0	0.1169	13.8
091	0058	OCCIDENTAL CHEMICAL CORP.	032	120.0	0.1333	8.4
091	0058	OCCIDENTAL CHEMICAL CORP.	033	126.0	0.0000	4.2
091	0058	OCCIDENTAL CHEMICAL CORP.	034	120.0	0.3054	0.0
091	0065	NORTH PENN HIDE CO.	031	50.4	0.0545	26.0
091	0065	NORTH PENN HIDE CO.	033	50.4	0.1192	5.5
091	0065	NORTH PENN HIDE CO.	034	50.4	0.1192	52.7
091	0077	FORD ELECTRONICS	099	0.0	0.0049	0.0
091	0078	FORD ELECTRONICS	099	0.0	0.0063	0.0
091	0102	MCNEIL PHARMACEUTICAL	031	0.0	0.0060	0.0
091	0102	MCNEIL PHARMACEUTICAL	032	0.0	0.0060	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	031	0.0	0.0171	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	032	51.0	0.0431	11.1
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	033	51.0	0.0000	9.7
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	034	0.0	0.0162	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	035	0.0	0.0094	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	037	0.0	0.0178	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	038	0.0	0.0149	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	040	0.0	0.0006	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	041	0.0	0.0006	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	042	0.0	0.0149	0.0
091	0118	SMITHKLINE BEECHAM PHARMACEUTICALS	043	0.0	0.0149	0.0
101	1501	SUN REFINING AND MARKETING 1 O	033	169.0	0.4689	0.0
101	1501	SUN REFINING AND MARKETING 1 O	034	169.0	0.4689	0.0
101	1501	SUN REFINING AND MARKETING 1 O	035	203.0	0.5714	0.0
101	1511	CHEVRON USA INC. REFINERY	001	0.0	0.4285	0.0
101	1511	CHEVRON USA INC. REFINERY	002	0.0	0.0415	0.0
101	1511	CHEVRON USA INC. REFINERY	010	0.0	0.0015	0.0
101	1511	CHEVRON USA INC. REFINERY	037	450.0	0.9300	342.0
101	1511	CHEVRON USA INC. REFINERY	038	450.0	0.9300	342.0
101	1511	CHEVRON USA INC. REFINERY	039	450.0	0.9300	342.0
101	1511	CHEVRON USA INC. REFINERY	040	600.0	1.2400	456.0
101	1521	GENERAL ELECTRIC CO	006	102.0	0.0003	0.0
101	1521	GENERAL ELECTRIC CO	007	57.0	0.0001	0.0
101	1521	GENERAL ELECTRIC CO	008	69.0	0.0001	0.0
101	1531	ROHM & HAAS	014	92.0	0.1675	0.0
101	1531	ROHM & HAAS	015	0.0	0.1580	0.0
101	1531	ROHM & HAAS	016	92.0	0.1580	0.0
101	1531	ROHM & HAAS	020	0.0	0.0075	0.0
101	1531	ROHM & HAAS	021	0.0	0.0045	0.0
101	1531	ROHM & HAAS	022	0.0	0.0045	0.0
101	1561	ALDAN RUBBER CO	001	25.0	0.0091	0.0
101	1566	CONTAINER CORP OF AMER	002	240.0	0.0979	0.0
101	1584	PROGRESS LIGHTING CO	001	17.0	0.0108	0.0
101	1584	PROGRESS LIGHTING CO	002	7.0	0.0124	0.0
101	1585	KURZ-HASTINGS INC	001	7.0	0.0050	0.0
101	1591	PAPER MANUFACTURERS	001	17.0	0.0272	0.0
101	1596	INTERNATIONAL PAPER CO	001	4.0	0.0010	0.0

ICI Boilers - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Rated Capacity (MMBtu/hr)	1990 Daily NOx Emissions (tons)	1990 Annual NOx Emissions (tons)
101	2062	G SPRUANCE CO	001	5.0	0.0006	0.0
101	2067	SKF IND.	001	43.0	0.0082	0.0
101	3048	PHILADELPHIA BAKING CO. GRANT	003	8.0	0.0063	0.0
101	3154	JOWITT AND RODGERS CO	003	0.0	0.0002	0.0
101	3164	LAFRANCE CASTING CO	004	5.0	0.0020	0.0
101	3217	GENERAL ELECTRIC CO	001	7.0	0.0006	0.0
101	3303	SMITH KLINE BECKMAN	012	27.0	0.0229	0.0
101	3303	SMITH KLINE BECKMAN	013	27.0	0.0229	0.0
101	3363	ALLIED TUBE&CONDUIT	005	0.0	0.0084	0.0
101	3542	MCWHORTER	002	84.0	0.0053	0.0
101	3542	MCWHORTER	003	0.0	0.0006	0.0
101	3811	ARBILL INDUSTRIES	001	5.0	0.0014	0.0
101	3811	ARBILL INDUSTRIES	002	5.0	0.0014	0.0
101	3887	CARDONE IND. 5670 RISING SUN	004	0.0	0.0028	0.0
101	4922	PHILA GAS WORKS-STA B	010	7.0	0.0024	0.0
101	4922	PHILA GAS WORKS-STA B	011	3.0	0.0007	0.0
101	5003	GATX ALLEGHENY AVE AND DELAWAR	001	20.0	0.0082	0.0
101	5004	BP OIL CORP	001	1.0	0.0001	0.0
101	5016	DIAMOND PETROLEUM	005	30.0	0.0208	0.0
101	5112	CONTAINER RECYCLERS LTD	002	10.0	0.0026	0.0
101	9702	U.S. NAVAL BASE	006	125.0	0.3267	0.0
101	9702	U.S. NAVAL BASE	007	125.0	0.5095	0.0
101	9702	U.S. NAVAL BASE	008	125.0	0.4662	0.0
101	9702	U.S. NAVAL BASE	009	126.0	0.6872	0.0
101	9702	U.S. NAVAL BASE	016	120.0	0.0938	0.0
101	9702	U.S. NAVAL BASE	056	6.0	0.0024	0.0
101	9702	U.S. NAVAL BASE	17a	0.0	0.0068	0.0
101	9702	U.S. NAVAL BASE	17b	0.0	0.0068	0.0
101	9702	U.S. NAVAL BASE	17c	0.0	0.0068	0.0
101	9702	U.S. NAVAL BASE	17d	0.0	0.0068	0.0
101	9702	U.S. NAVAL BASE	17e	0.0	0.0068	0.0
101	9702	U.S. NAVAL BASE	17f	0.0	0.0068	0.0

Process Heaters - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Rated Capacity (MMBtu/hr)	1990 Daily NOx Emissions (tons)	1990 Annual NOx Emissions (tons)
029	0024	LUKENS STEEL CO.	183	0.00	0.3438	0.0000
045	0025	SUN REFINING & MARKETING CO.	036	54.00	0.1343	40.7000
045	0025	SUN REFINING & MARKETING CO.	037	0.00	0.0637	0.0000
045	0025	SUN REFINING & MARKETING CO.	038	0.00	0.1117	0.0000
045	0025	SUN REFINING & MARKETING CO.	039	0.00	0.0796	0.0000
045	0025	SUN REFINING & MARKETING CO.	040	120.00	0.0865	28.6000
045	0025	SUN REFINING & MARKETING CO.	045	0.00	0.0311	0.0000
045	0025	SUN REFINING & MARKETING CO.	046	56.00	0.1503	52.1000
045	0025	SUN REFINING & MARKETING CO.	060	222.50	0.4315	0.0000
045	0025	SUN REFINING & MARKETING CO.	067	72.90	0.1908	64.5000
045	0025	SUN REFINING & MARKETING CO.	068	57.50	0.1385	50.8000
045	0025	SUN REFINING & MARKETING CO.	069	0.00	0.1000	0.0000
045	0025	SUN REFINING & MARKETING CO.	070	0.00	0.0630	0.0000
045	0025	SUN REFINING & MARKETING CO.	071	90.50	0.1629	91.8000
045	0025	SUN REFINING & MARKETING CO.	072	86.80	0.1482	44.0000
045	0025	SUN REFINING & MARKETING CO.	073	86.80	0.1470	44.0000
045	0025	SUN REFINING & MARKETING CO.	074	0.00	0.0346	0.0000
045	0025	SUN REFINING & MARKETING CO.	075	191.50	0.1374	40.9000
045	0025	SUN REFINING & MARKETING CO.	076	191.50	0.1374	40.9000
045	0025	SUN REFINING & MARKETING CO.	077	191.50	0.1374	40.9000
045	0025	SUN REFINING & MARKETING CO.	078	56.20	0.0374	24.0000
045	0025	SUN REFINING & MARKETING CO.	079	0.00	0.0189	0.0000
045	0025	SUN REFINING & MARKETING CO.	080	0.00	0.0896	0.0000
045	0025	SUN REFINING & MARKETING CO.	081	0.00	0.0343	0.0000
045	0025	SUN REFINING & MARKETING CO.	082	0.00	0.0254	0.0000
045	0025	SUN REFINING & MARKETING CO.	083	94.80	0.1074	87.7000
045	0025	SUN REFINING & MARKETING CO.	084	94.80	0.1074	87.7000
045	0025	SUN REFINING & MARKETING CO.	085	94.80	0.1074	87.7000
045	0025	SUN REFINING & MARKETING CO.	086	94.80	0.2362	87.7000
045	0025	SUN REFINING & MARKETING CO.	087	163.00	0.2244	149.4000
045	0025	SUN REFINING & MARKETING CO.	088	246.10	0.3315	227.0000
045	0025	SUN REFINING & MARKETING CO.	104	0.00	0.0038	0.0000
045	0030	BP OIL, INC.	031	218.00	0.4751	76.6000
045	0030	BP OIL, INC.	034	50.00	0.1318	48.1000
045	0030	BP OIL, INC.	035	0.00	0.0076	0.0000
045	0030	BP OIL, INC.	036	0.00	0.0317	0.0000
045	0030	BP OIL, INC.	037	75.00	0.0780	28.0000
045	0030	BP OIL, INC.	038	600 ~~0.00~~	4.0746	0.0000
045	0030	BP OIL, INC.	039	0.00	0.0562	0.0000
045	0030	BP OIL, INC.	040	52.00	0.1305	43.2000
045	0030	BP OIL, INC.	041	0.00	0.0961	0.0000
045	0030	BP OIL, INC.	042	69.00	0.0479	17.3000
045	0030	BP OIL, INC.	043	80.00	0.0421	15.2000
045	0030	BP OIL, INC.	044	240.00	1.7180	157.9000
045	0030	BP OIL, INC.	045	240.00	1.8458	171.5000
045	0030	BP OIL, INC.	046	180.00	0.6027	56.0000
045	0030	BP OIL, INC.	102	0.00	0.0710	0.0000
045	0030	BP OIL, INC.	C01	0.00	0.1407	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	001	13.00	0.0070	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	003	13.00	0.0070	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	008	235.40	0.6636	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	009	211.40	0.6416	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	010	63 30	0.3639	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	011	17.00	0.0314	0 0000
101	1501	SUN REFINING AND MARKETING 1 O	012	108 00	0.2439	0.0000

Process Heaters - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Rated Capacity (MMBtu/hr)	1990 Daily NOx Emissions (tons)	1990 Annual NOx Emissions (tons)
101	1501	SUN REFINING AND MARKETING 1 O	013	144.00	0.3250	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	014	59.20	0.2503	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	015	54.00	0.2629	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	016	45.50	0.0355	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	017	54.60	0.1272	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	018	85.10	0.0990	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	019	410.00	0.6875	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	020	205.00	0.6985	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	029	57.00	0.0462	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	030	45.00	0.0371	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	031	43.00	0.0301	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	040	23.90	0.2138	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	041	145.00	0.2138	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	042	30.00	0.0167	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	043	45.00	0.0700	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	045	165.00	0.1128	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	046	28.20	0.0112	0.0000
101	1501	SUN REFINING AND MARKETING 1 O	051	50.00	0.0200	0.0000
101	1511	CHEVRON USA INC. REFINERY	001	0.00	0.6385	0.0000
101	1511	CHEVRON USA INC. REFINERY	005	0.00	0.6435	0.0000
101	1511	CHEVRON USA INC. REFINERY	009	0.00	0.1310	0.0000
101	1511	CHEVRON USA INC. REFINERY	010	0.00	0.3565	0.0000
101	1511	CHEVRON USA INC. REFINERY	014	0.00	0.2870	0.0000
101	1511	CHEVRON USA INC. REFINERY	023	0.00	0.0680	0.0000

IC Engines - Natural Gas and Oil-Fired
Non-Affected OTC MOU Units

FIPSCNTY	PLANTID	PLANT	POINT	Horsepower	1990 Daily NOx Emissions (tons)
029	0044	COLUMBIA GAS TRANSMISSION CORP.	031	1,250	0.4260
029	0044	COLUMBIA GAS TRANSMISSION CORP.	032	1,250	0.4800
029	0045	COLUMBIA GAS TRANSMISSION CORP.	036	1,300	0.3614
029	0045	COLUMBIA GAS TRANSMISSION CORP.	037	1,300	0.3711
029	0045	COLUMBIA GAS TRANSMISSION CORP.	038	1,300	0.3846
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	031	2,050	0.6574
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	032	2,050	0.6585
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	033	2,050	0.6575
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	034	2,050	0.6580
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	035	2,050	0.6584
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	036	2,050	0.7812
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	037	2,100	0.7000
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	038	2,100	0.6464
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	039	2,100	0.6460
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	040	2,100	0.5248
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	041	3,400	1.0289
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	042	3,400	1.1741
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	043	5,500	0.6467
029	0047	TRANSCONTINENTAL GAS PIPE LINE CORP	044	0	0.0121
029	0058	EASTERN SHORE NATURAL GAS CO.	031	450	0.0857
029	0058	EASTERN SHORE NATURAL GAS CO.	032	450	0.0875
045	0045	COGENERATION PARTNERS OF AMERICA	031	0	0.4591
045	0045	COGENERATION PARTNERS OF AMERICA	032	0	0.4860
101	4922	PHILA GAS WORKS-STA B	013	2,000	0.5746
101	4922	PHILA GAS WORKS-STA B	014	2,000	0.5746
101	4922	PHILA GAS WORKS-STA B	015	0	0.0986
101	9702	U.S. NAVAL BASE	079	0	0.5361

Further Analysis of Potential Control Measures for the Five-County Area

November 7-8, 1996

Presentation at the Southeast Pennsylvania Ozone Stakeholders Meeting

E.H. Pechan & Associates, Inc.
Springfield, VA 22151

Presentation Focus On:

1. Stationary Source NO_x Control Measure Evaluations

Measure 13:	Utility Boilers
Measure 14:	Industrial Boilers
Measure 20:	Gas Turbines: Oil
Measure 22:	Reciprocating IC Engines: Natural Gas
Measure 23:	Process Heaters: Natural Gas or Oil
Measure 25:	Industrial, Commercial, and Institution Combustion

2. Measures with New Information

Control Cost Estimates

1. Capital Cost (initial investment).

2. Operating and Maintenance Cost.

3. Recovery Credit (materials recovered).

Usually compare annual cost and annual benefit.

Except where summer season ozone controls might only be in place for five months.

PECO Energy Fossil-Steam Units

Unit	Primary Fuel	Pre-RACT NO_x Emission Rate (lb/million Btu)	Post-RACT NO_x Emission Rate (lb/million Btu)	NO_x RACT Control
Cromby 1	Coal	0.6	0.35	LNB with SOFA
Cromby 2	Oil/Gas	0.26	0.23	Air Biasing
Delaware 7	Oil	0.45	0.43	Tuning
Delaware 8	Oil	0.42	0.42	Tuning
Eddystone 1	Coal	0.52	0.38	LNB with SOFA
Eddystone 2	Coal	0.55	0.37	LNB with SOFA
Eddystone 3	Oil/Gas	0.31	0.23	Overfire Air
Eddystone 4	Oil/Gas	0.37	0.23	Overfire Air
Schuylkill 1	Oil	0.31	0.31	Air Biasing

PECO Energy Fossil-Steam Units

Unit	County	Generator Nameplate Capacity (MW)	Start Date
Cromby 1	Chester	187.5	1954
Cromby 2	Chester	230.0	1955
Delaware 7	Philadelphia	156.3	1953
Delaware 8	Philadelphia	156.3	1953
Eddystone 1	Delaware	353.6	1959
Eddystone 2	Delaware	353.6	1960
Eddystone 3	Delaware	391.0	1974
Eddystone 4	Delaware	391.0	1976
Schuylkill 1	Philadelphia	190.4	1958

NO_x Controls Beyond Phase II

PECO Energy supplied a Stone and Webster screening study.

1. Concluded that SCR is not applicable due to physical limitations at all units except Eddystone 3 and 4.

2. Estimated SCR costs at Eddystone 3 and 4 to be $14,583 per ozone season NO_x ton.

3. On an annual basis, this CE = $6,076 per ton.

The above CE value — with some site-specific information — compares with Pechan's generic estimate of $4,000-$5,000 per ton.

Phase II NO_x MOU Compliance Options

1. Purchase emission rights from sources that have overcontrolled.

2. Fire 100 percent natural gas in oil/gas units.

3. Some natural gas reburn at coal units.

Estimated Cost of Meeting Phase II NO_x Levels

Unit	Assumed Control	Capital Cost (millions)	$/ton removed	Emission Rate (lbs/mmbtu)	Ozone Season Emissions
Phase II					
Cromby 1	None	0	0	0.35	647
Cromby 2	Natural Gas	0	6,800	0.15	288
Delaware 7	None	0	0	0.43	133
Delaware 8	None	0	0	0.42	124
Eddystone 1	Reburn	21	3,000 - 4,000	0.17	463
Eddystone 2	Reburn	22	3,000 - 4,000	0.17	559
Eddystone 3	Natural Gas	0	6,800	0.15	385
Eddystone 4	Natural Gas	0	6,800	0.15	381
Schuylkill 1	None	0	0	0.31	141

Phase III NO_x MOU Compliance Options

1. Apply SCR at Eddystone 3 and 4.

2. Ozone season natural gas use at Cromby 2 and Eddystone 3 and 4.

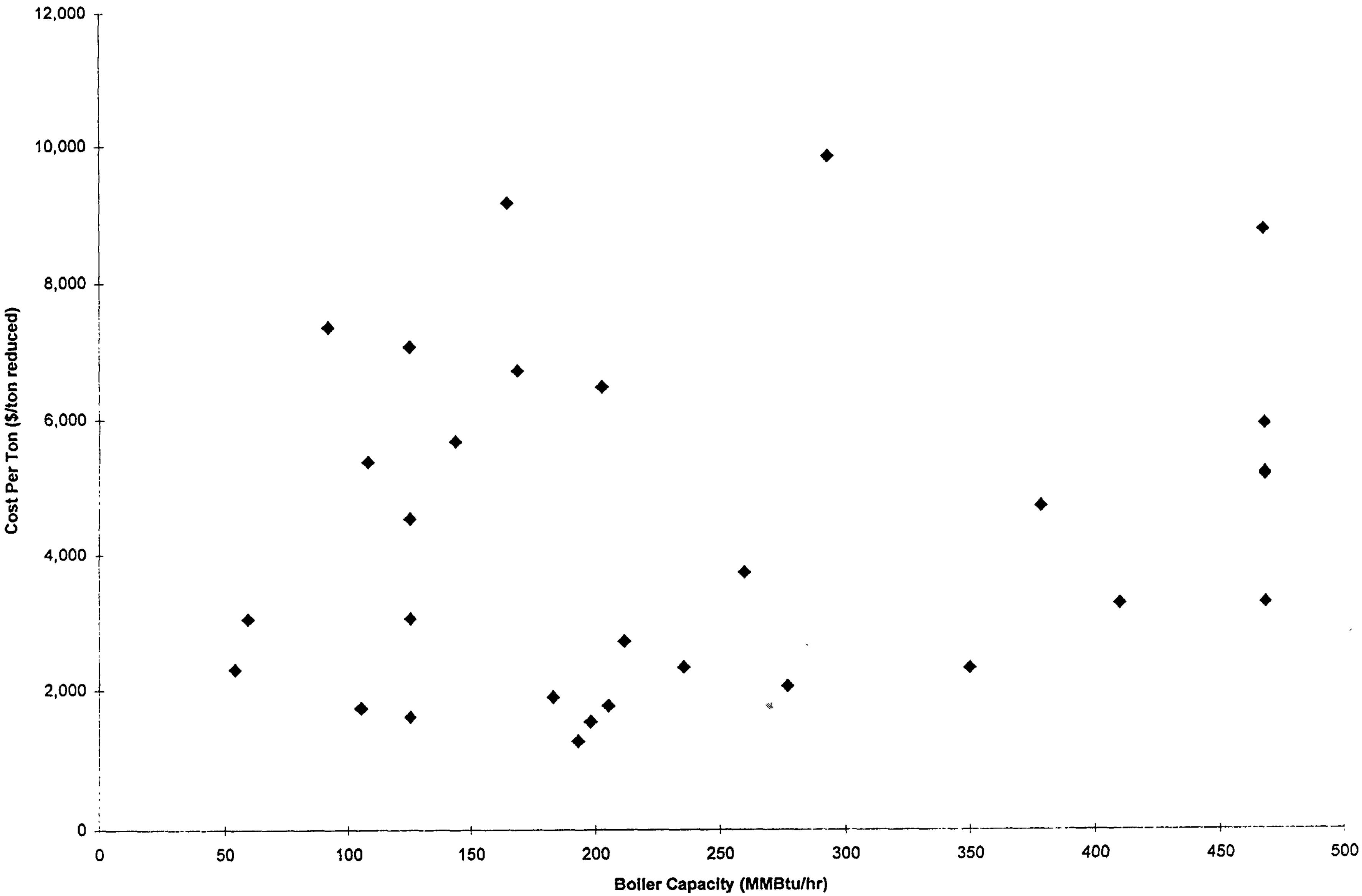
If SCR is infeasible at Eddystone due to space, or other reasons, options are limited to:

1. Purchase of emission rights.

2. Complete conversion to natural gas at all units.

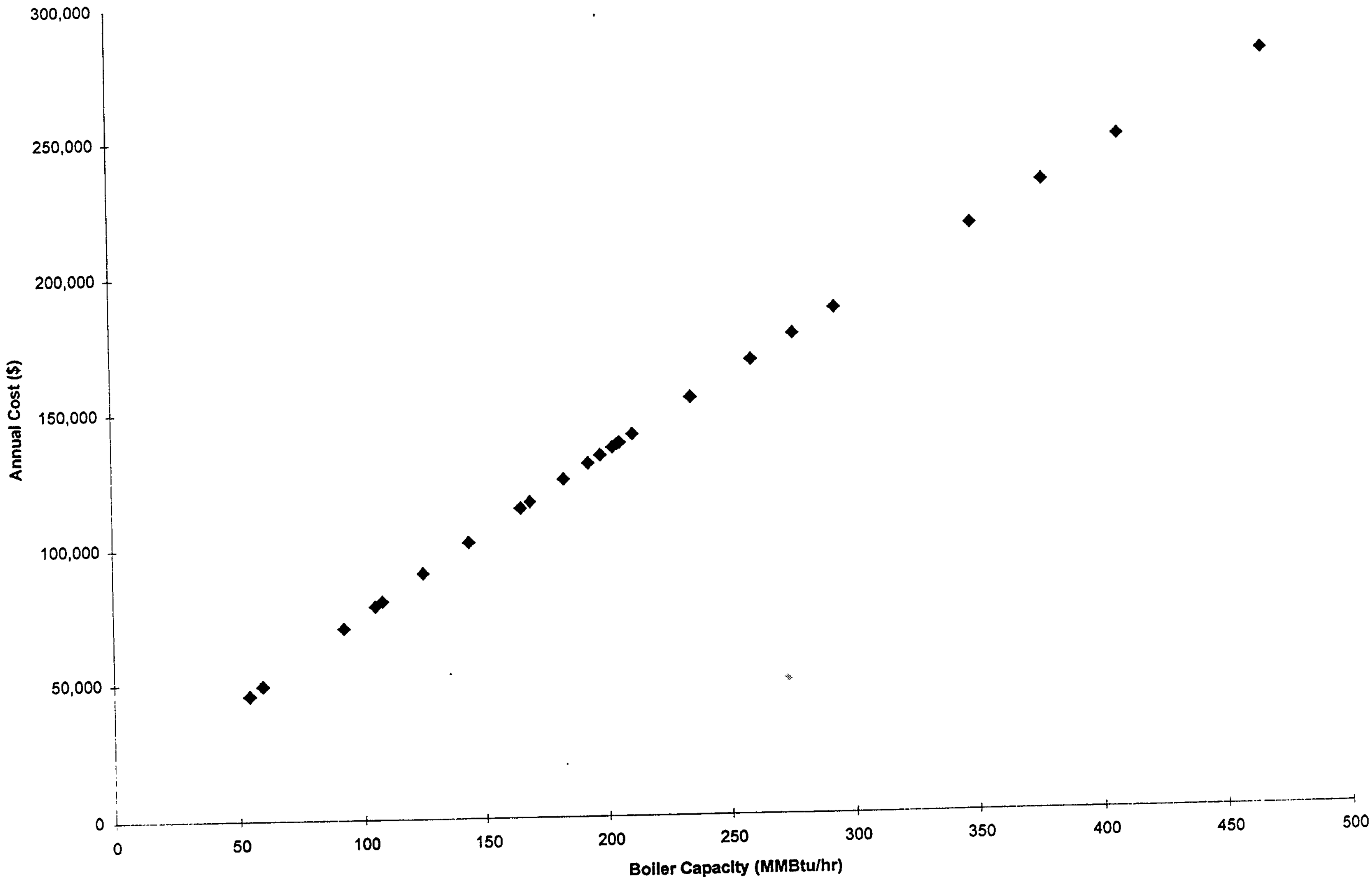
3. Power purchases outside PECO.

Industrial Boilers ...atural Gas-Fired
Cost-Effectiveness of LNB + FGR Control

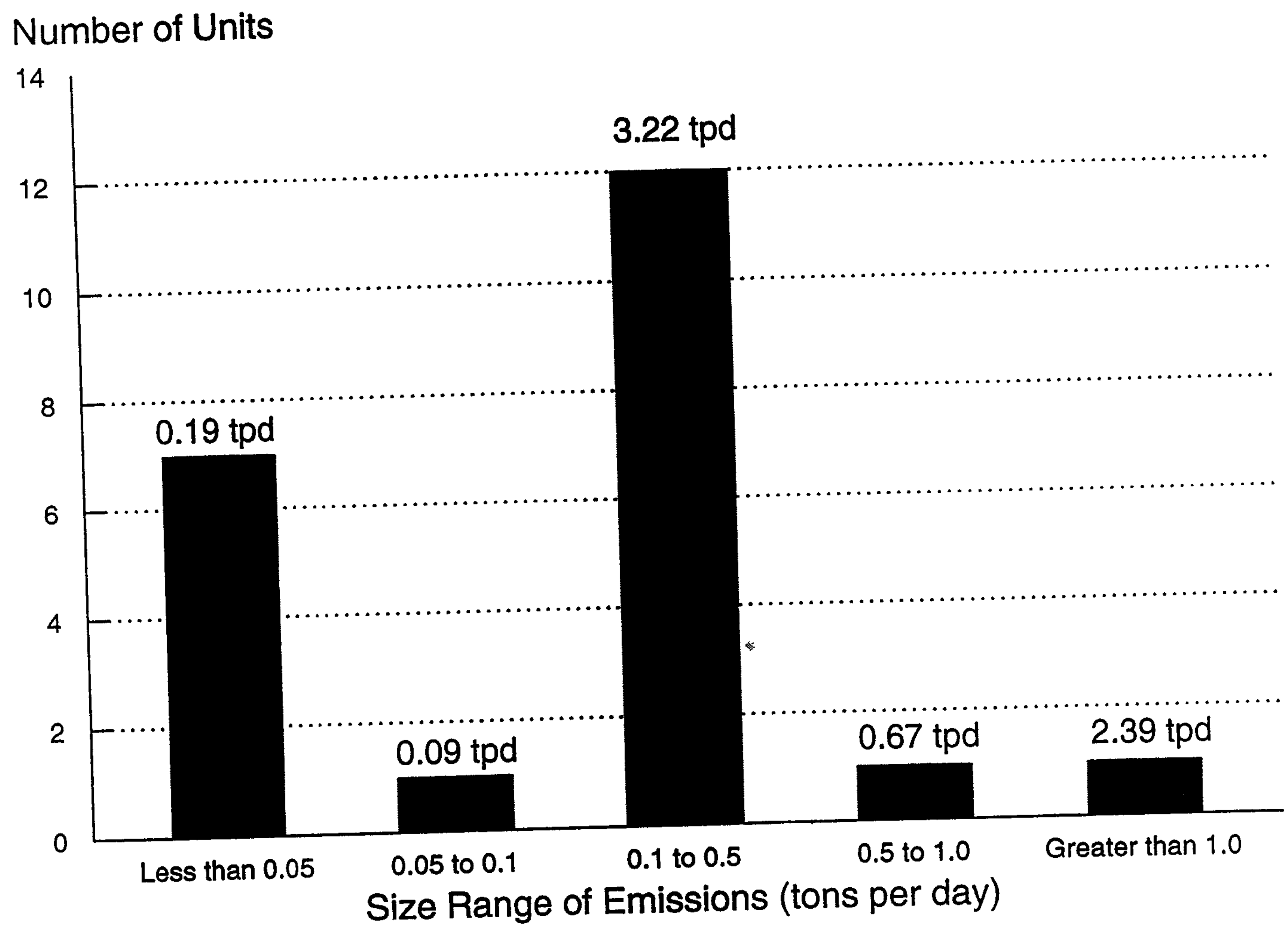


Annual emission estimation based on hours of operation per year.

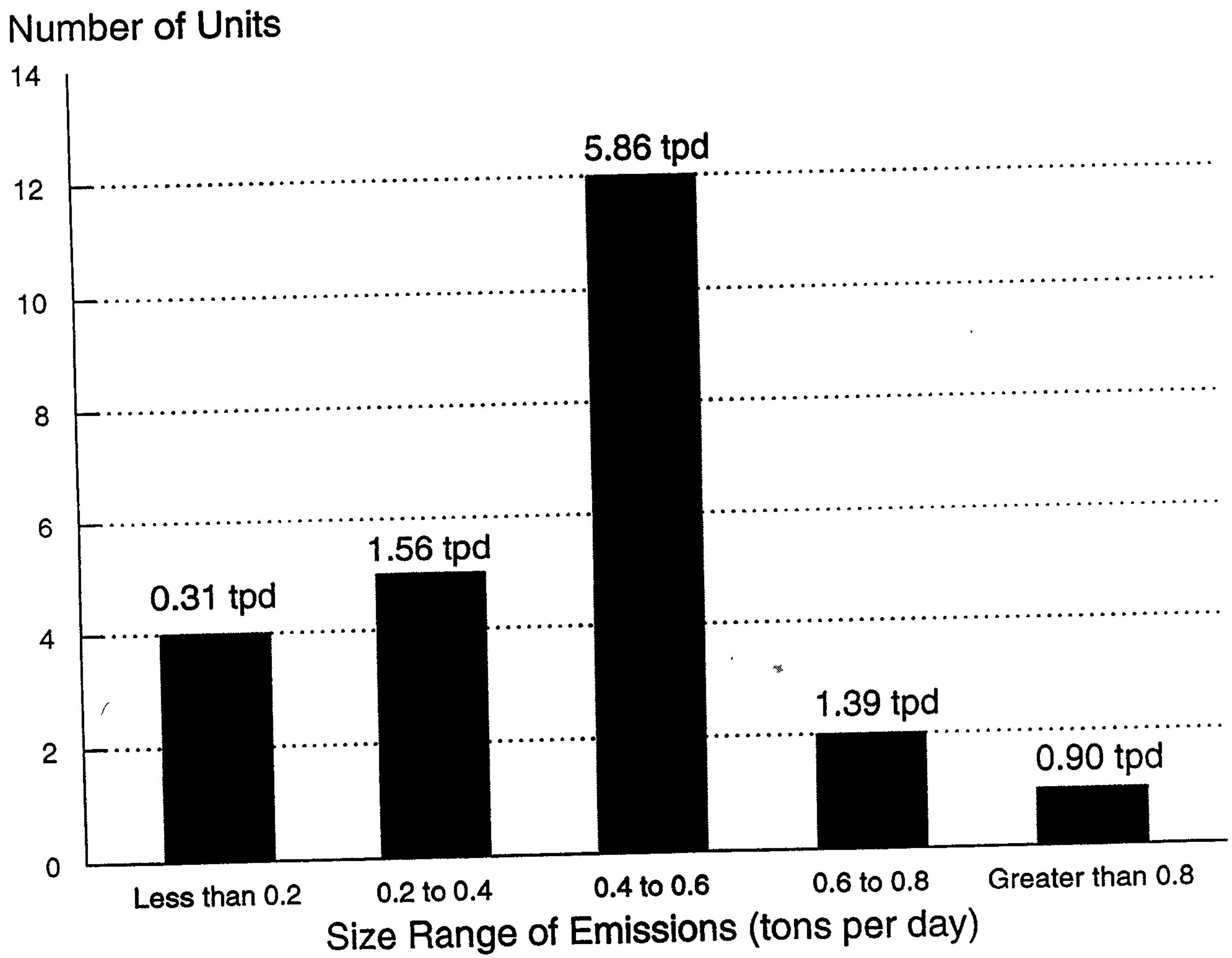
Industrial Boilers - Natural Gas-Fired
Cost for LNB + FGR Control



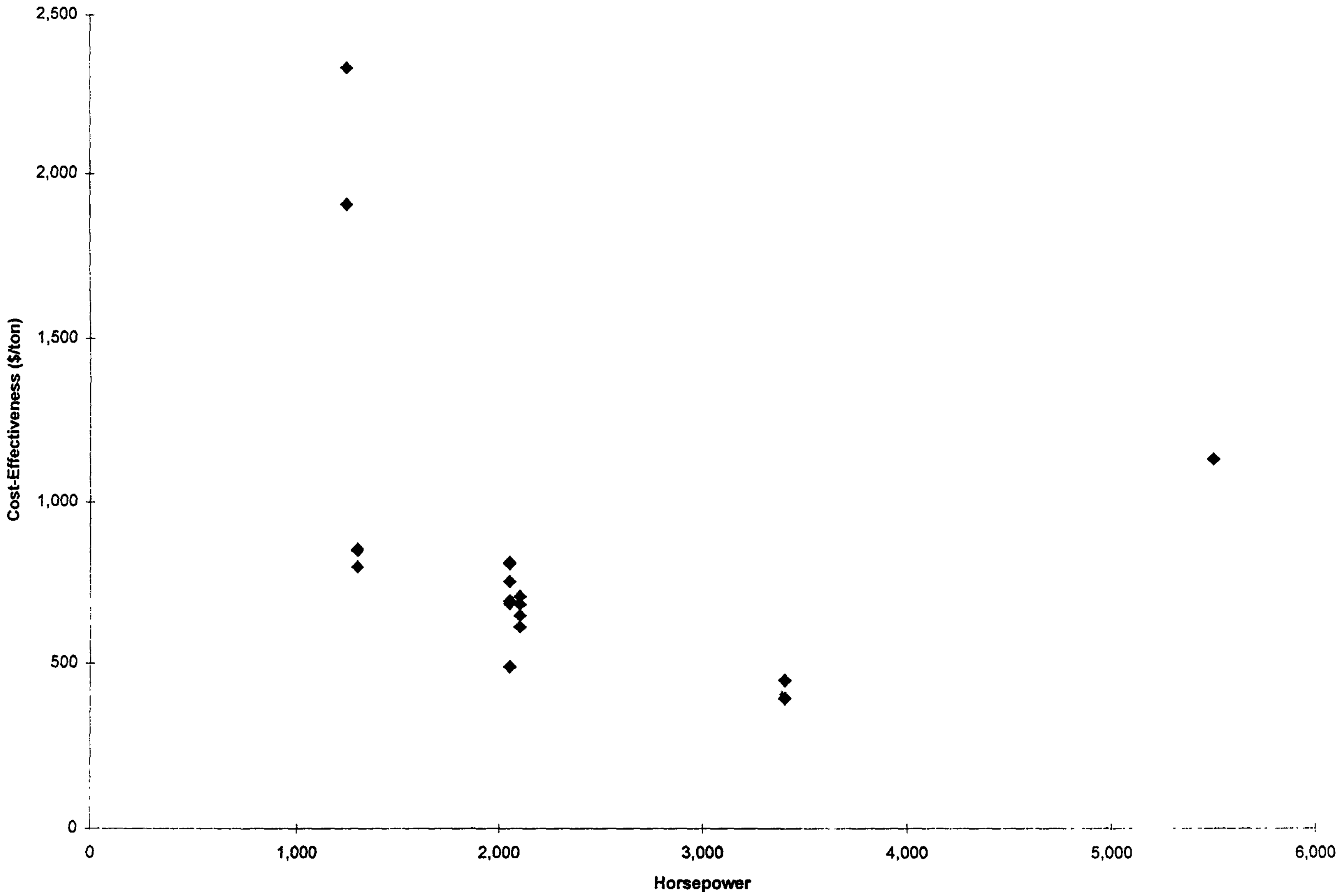
Control Measure #20
Gas Turbines: Oil
Distribution of Units by Emission Size Category



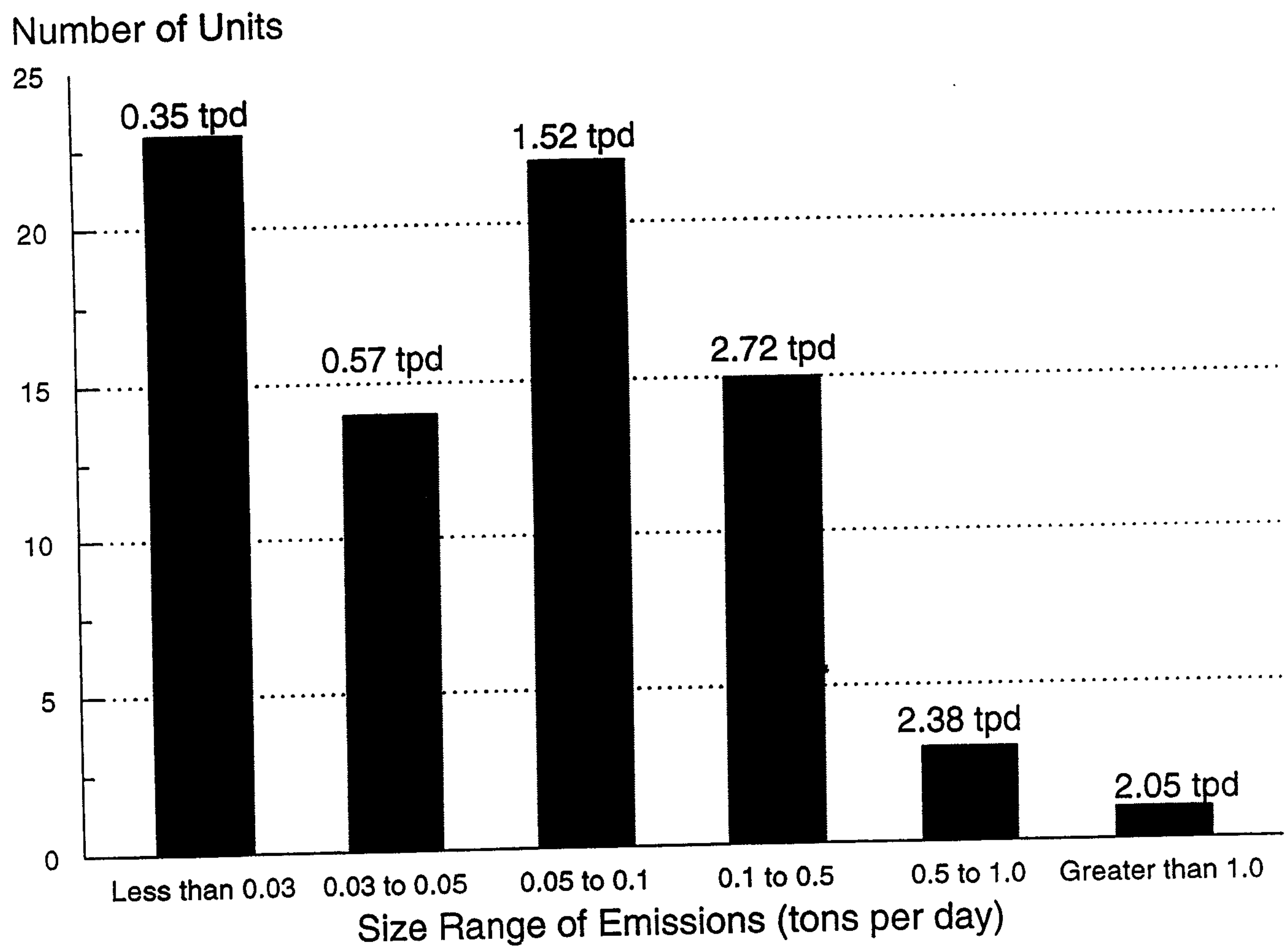
Control Measure #22
Stationary Reciprocating IC Engines: Natural Gas
Distribution of Units by Emission Size Category



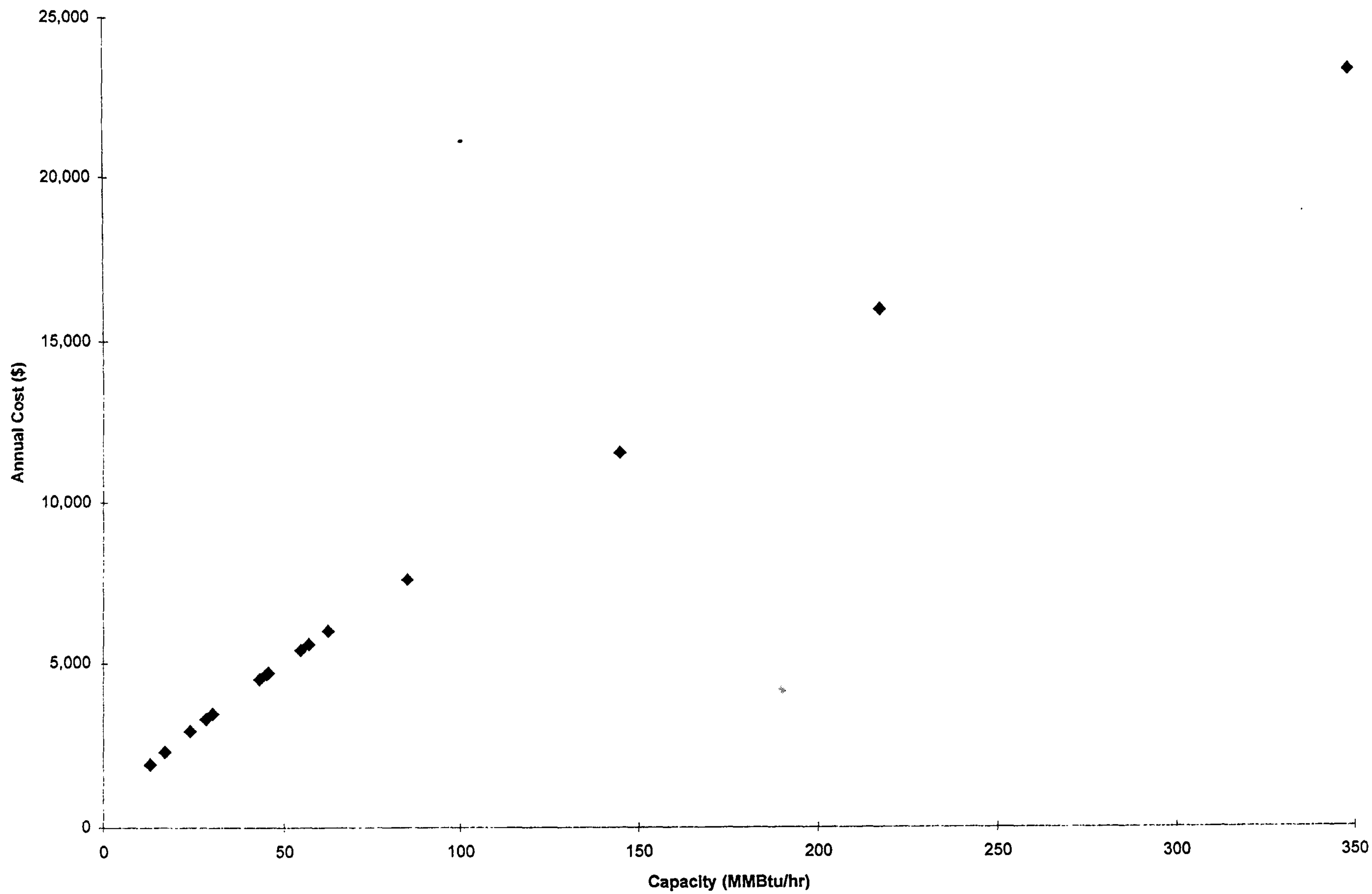
Internal Combustion Engines - Gas-Fired
Cost-Effectiveness of NSCR Control



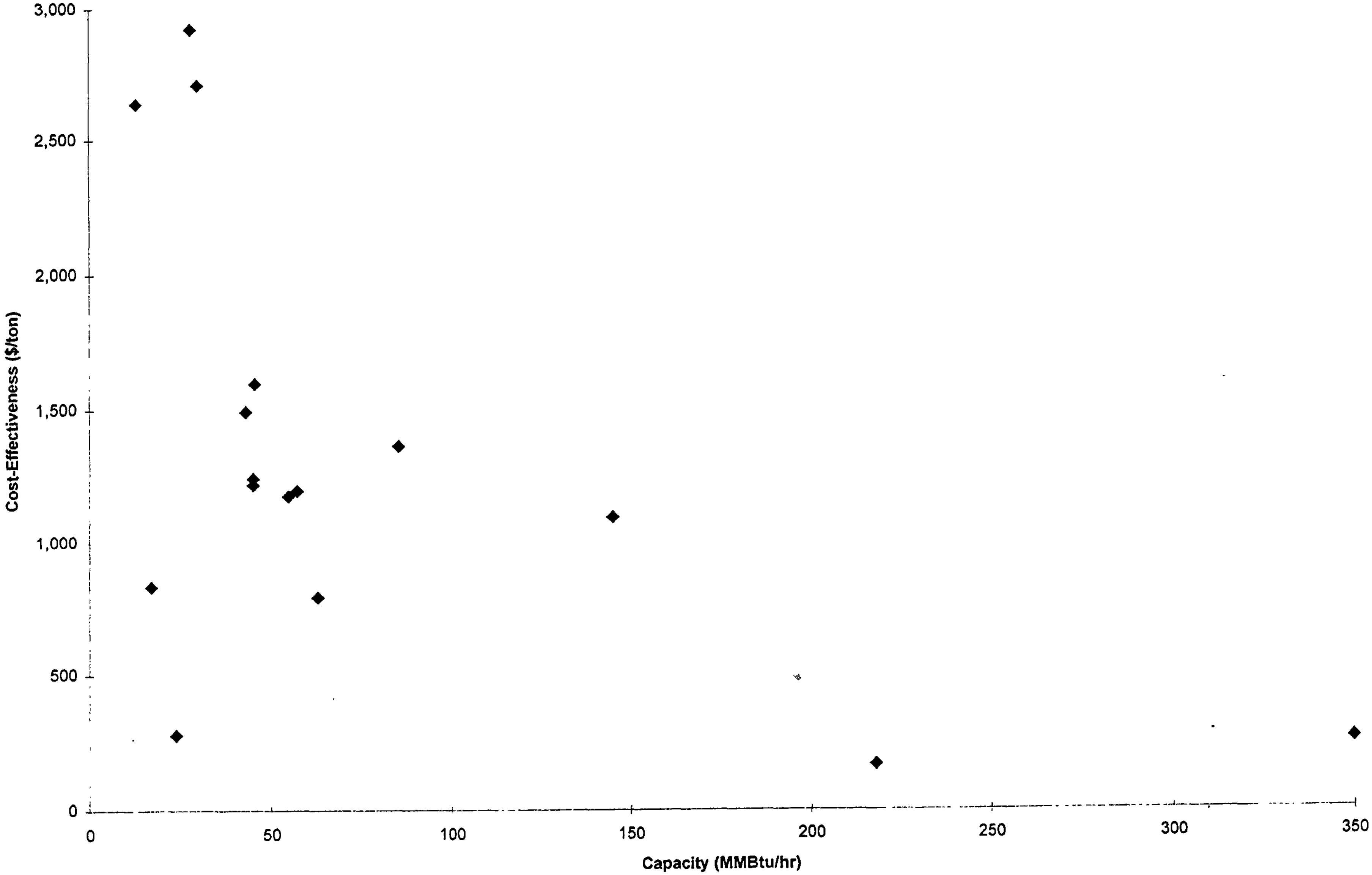
Control Measure #23
Process Heaters: Natural Gas or Oil
Distribution of Units by Emission Size Category



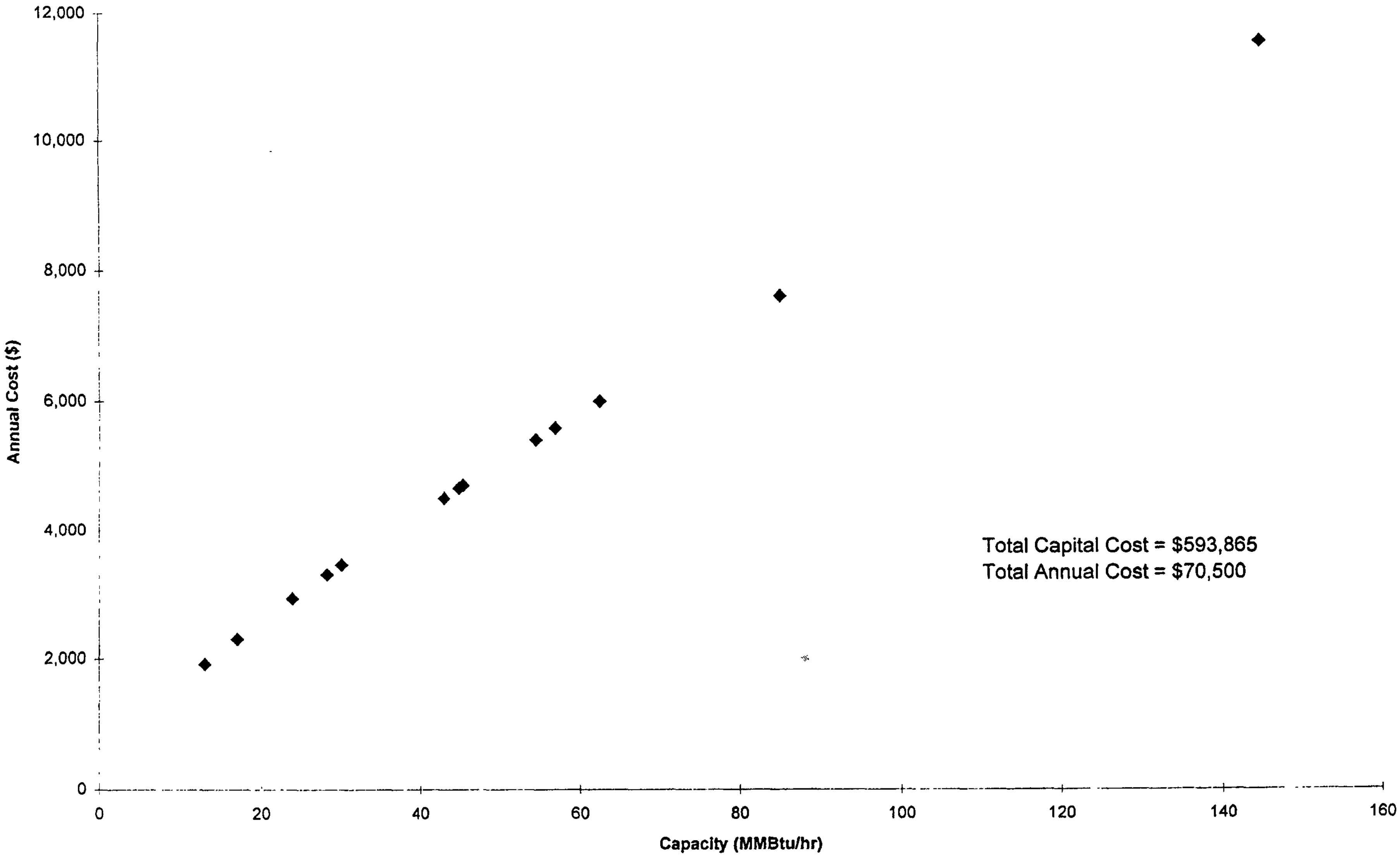
Process Heaters - Natural Gas-Fired
Annual Cost of LNB + FGR Control



Process Heaters - Natural Gas-Fired
Cost-Effectiveness of LNB + FGR Control



Philadelphia County
Sun Refining and Marketing
Process Heaters - Natural Gas-Fired
Annual Cost of LNB + FGR Control



Measure #25: RACT to Small NO_x Sources

Facilities with NO_x emissions above 100 tpy are included as point sources.

A fuel balance is used to estimate emissions not covered by the point source file.

Pennsylvania fuel consumption by fuel type in 1990

- Commercial
- Residential

Allocated to counties by number of natural gas units (or oil units).

Area source fuel use * NO_x emission factor = Annual tons.

Point Source NO_x Emitters Potentially Affected by Measure #25

Examples include boilers at:

West Chester University

Southeast Pennsylvania Veterans Center

Haverford State Hospital

Norristown State Hospital

Kurz-Hastings Inc.

Philadelphia Baking Co.

Measure #25
Temporal Allocation Factor Application

	2005 NO_x TPD	Equivalent Annual Tons
Commercial/Institutional Distillate Oil	9.03	3,296
Commercial/Institutional Natural Gas	12.03	4,390

	Revised 2005 NO_x TPD	Summer Season Factor	Weekday Factor
Commercial/Institutional Distillate Oil	5.64	.15	.01140
Commercial/Institutional Natural Gas	12.03	.25	.01099

Measure #8: Rule Effectiveness Improvements

VOC benefits of achieving 100% rule effectiveness were estimated.

Maximum benefits of 21.7 tpd were estimated.

Most of this is from solvent utilization-surface coating (16.4 tpd).

Measure #38: Heavy-Duty Vehicle Emission Inspections

Colorado and Arizona have dynamometer-based testing (opacity).

Contrast with random, roadside testing in 12-14 States.

Only locally registered trucks are affected (examples cement and gravel haulers).

Diesels are tested primarily as an equity issue.

Trucking industry is concerned about having uniformity in emission inspections.

Do heavy-duty diesels have higher NO_x emission rates than estimated by MOBILE5?

Conflicting evidence:

- Radian (1988) study for California shows excess NO_x emissions (modeled values too low by a factor of 2).
- EPA HDE certification data shows no NO_x deterioration with accumulated mileage.

Heavy-Duty Vehicle Emission Inspections

Is remote sensing of NO_x from trucks viable?

Issues to resolve:

- Different tailpipe heights.
- NO_x measurement technology.
- Solid particles in the plume.

Measure #100: Area Source Business Credits for Alternative Fuel Vehicles

Credits could be produced by:

1. Applying control technology earlier than required.

2. Use of emission control equipment not otherwise required.

CA MSERC Program Guidelines address credits for:

- Accelerated retirement of older vehicles.
- Purchase of low emission transit buses.
- Purchase of zero emission vehicles.
- Retrofit of light and medium-duty vehicles.
- Retrofit of heavy-duty vehicles.
- Purchase of new, reduced emission heavy-duty vehicles.

Number of Vehicles Needed to Generate 25 Tons Per Year of Emission Reduction Credits in 1993

	Approximate Number of Vehicles Needed			
Emission Reduction Credit Program	**ROG**	**NO_x**	**Approximate Cost**	**Expected Life of Credits**
Accelerated Retirement of Old Cars[B]	440		$350,000	3 Years
		1,700	$1.3 Million	
Low-emission Transit Buses (Methanol M100)	NC[C]	50	$1.9 Million to $3.5 Million[A,D]	12 Years
Low-emission Transit Buses (CNG)	NC[C]	50	$400,000 to $2.2 Million[A,D]	12 Years
Electric Transit Buses	NC[C]	25	NC[E]	18 Years
Zero-emission Vehicles[G]	3,800	3,800	NC[F]	10 Years
Light- and Medium-Duty Retrofit[H]	4,200[H]	4,200[H]	NC[I]	10 Years[H]
Heavy-Duty Retrofit[J]	NC[K]	58	NC[I]	3 Years[J]

Measures #105 and 106: Electric Lawnmowers

Need to have electrics (cordless) be cost competitive with gasoline. On a lifetime cost basis, they probably already are if fuel savings and maintenance costs are considered.

Cost effectiveness is sensitive to the cost difference from gasoline-powered mowers.

Not viable in commercial service because of charging needs.

Options:

ERC programs.

Ban sale of new gasoline-powered.

Use market forces and public education to achieve x percent market penetration by 2005.

Measures #105 and 106: Lawnmowers

The national population is estimated to be 33 million mowers now.

Yearly sales are 15 to 20 percent of this figure.

The VOC cost effectiveness of $1,200 per ton is based on consumer use of electric lawnmowers, at a $75 initial cost difference from gasoline-powered lawnmowers.

Measure #116: Lawn and Garden Equipment Ban on High Ozone Days

	2005 Emissions	Reduction via Ban with 80% RE
Residential Use	14.0 tpd VOC	11.2 tpd
Commercial Use	16.1 tpd VOC	12.8 tpd

Emission reductions are based on restricting use of all lawn and garden equipment, not just lawnmowers.

No cost assumed to residential users. Commercial costs evaluated at $20 per hour times 8 hours times mowers in commercial service.

Hand Held Gasoline-Powered Equipment
National Shipments

	1990	1991	1994
Chain Saws	1,378,000	1,153,000	1,918,915
Trimmers and Brushcutters	2,962,000	2,967,000	3,906,672
Hand-Held Blowers	655,000	728,000	922,130
Back Pack Blowers	87,000	73,000	163,284
Hedge Trimmers	na	104,000	204,165
Cut Off Saws	na	27,000	84,032

SOURCE: Portable Power Equipment Manufacturers Association, 1996.

Measure #128: Expand Reformulated Gasoline Area

OTAG mobile source cost matrix has a 6.7 to 11.9 cent per gallon cost range for Federal RFG-Phase II including fuel economy penalty.

The OTAG cost per ton range is $3,500 to $6,200 per combined VOC plus NO_x ton.

Cost effectiveness in 4-county area (Lancaster, Northhampton, Berks, Lehigh Counties) was estimated to be $5,800 to $10,300 per ton based on ozone season day emissions and costs in these areas.

Costs are potentially affected by the size of the geographic area where new RFG sales are required.

Market data suggest that fuel price increases for Federal RFG I and California RFG II range from 2 to 4 cents per gallon after initial prices have stabilized.

Fuel economy penalty for any RFG averages 2.3 cents per gallon.

Measure #131: Leakless Gasoline Can Nozzles

Vapor recovery nozzles control refueling emissions from lawn and garden equipment.

Automatic stop device reduces spillage.

Reduces vapor loss via fuel displacement.

Retail Costs	$\leq$ 2 1/2 gallon can = \$4.89	
	> 2 1/2 gallon can = \$12.49	
Cost Per Ton	Residential	\$1,400-\$5,800 per VOC ton
	Commercial	\$130-\$290 savings per ton

To reach residential sector, nozzles must be available for sale at large hardware stores (Home Depot, Hechinger).

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
Primary Control Measures Under Consideration								
1	Industrial Surface Coating	Add-on Controls or VOC Content Limits				0	N/A	
	Wood Furniture - Point	1997 SCAQMD Limits	0.3	0.1	25			
	Wood Furniture - Area	CTG Limits	2.9	1.0	1,800-5,900			
	Auto Body	none (more stringent levels were not identified)	0.4	0	0			
	Can Coating	CARB RACT/BARCT	9.0	2.2	4,000-5,000			
	Misc. Metal Parts	CARB RACT/BARCT	2.2	0.7	4,260			
	Plastic/Rubber/Glass Parts	SCAQMD Limits	0.3	0.2	1,110			
	Fabric/Paper Coating	SCAQMD Limits	23.1	5.5	4,000-5,000			
	Vinyl Coating	SCAQMD Limits	N/A	41%	4,000-5,000			
	Magnet Wire	none (more stringent levels were not identified)	N/A	0				
	Coil Coating	CARB RACT/BARCT	0.9	0.3	4,000-5,000			
	Metal Furniture/Appl.	CARB RACT/BARCT	7.5	1.5	4,000-5,000			
	Industrial Adhesives	SCAQMD Limits	0.9	0.8	800-6,800	0	N/A	
2	Surface Coating - Aerospace	Extend RACT, VOC Content Limit						
	Aerospace Ctg. - Point	none (assumed to be covered by MACT)		0	0			
	Aerospace Ctg. - Area	MACT/SCAQMD limits	0.5	0.3	4,000-5,000			
3	Autobody Refinishing	VOC Content Limits; CA Best Available Retrofit Control Technology				0	N/A	
	Auto Ref. - Area	SCAQMD Limits	10.8	3.8	3,700			
4	Surface Cleaning/Degreasing	CARB's Best Available Control Technology; Low-VOC Solvents				0	N/A	
	Surface Cleaning/Degreasing	SCAQMD Limits	[illegible]	[illegible]	Cost Saving $100	[illegible]	[illegible]	
5	Gasoline Service Stations: Underground Storage Tanks	Install Pressure Vacuum (PV) Valves on Vent Line	0.2	0	20-615	0	N/A	

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
7	Petroleum Refinery Fugitive Emission Leaks	Inspection and Maintenance Program				0		
	Refinery Fugitives	More Stringent LDAR	5.3	1.0	680-1,150	0		
8	Rule Effectiveness Improvements	Increase Compliance with Regulations						
	Rule Effectiveness Improvements	Increased Compliance Activities		21.7	Unknown		0	
9	Web Offset Lithography	Carbon Adsorber				0		
	Web Offset Lithography	Beyond CTG Req. (e.g., carbon adsorp.)	0.7	~0	Unknown			
10	Graphic Arts	Low-VOC Inks and Cleaning Solvents				0		
	Graphic Arts	Extend RACT to Small Sources	2.4	1.5	3,500-4,800		N/A	
12	Pesticides	Reformulation to Lower VOC Content				0		
	Pesticides	CA FIP Rule	1.4	0.3	1,000			
13	Utility Boilers							
	Coal-Fired Boiler	LNB + Overfire Air Plus (Phase 2 NO_x MOU)	0.3			10.8		
	Coal-Fired Boiler	Selective Catalytic Reduction (SCR)	0.3			10.8	4.0	4,000
	Oil/Gas-Fired Boiler	LNB	0.8			23.2		
		SCR					9.0	4,400
14	Industrial Boilers		1.0			29.0		
	Coal-Fired	LNB	0.1			3.3	1.8	2,400
	Gas/Oil-Fired	LNB + Flue Gas Recirculation (FGR)				25.3	16.5	2,000-4,000
18	Glass Manufacturing	LNB	0*			1.6		
		SCR					1.2	800-2,950
		Oxy-Firing					1.2	2,150-5,300
19	Gas Turbines: Natural Gas	LNB SCR + Steam Injection	0	0		0	0	3,580-10,800
20	Gas Turbines: Oil	Water Injection NSCR + Water Injection	0.6	0		6.6	4.0	2,690-8,100

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
21	Reciprocating IC Engines: Diesel/Oil	Ignition Timing Retard	0	0		0.1		
		SCR					0.1	580-4,810
22	Reciprocating IC Engines: Natural Gas	Air/Fuel (AF) Ratio Adjustment + ITR	0.5	0		11.3		
		SCR					10.1	580-4,810
		NSCR					10.1	180-310
23	Process Heaters: Natural Gas or Oil	LNB + FGR	0.1	0		10.4	6.8	1,500-2,300
24	Iron and Steel Mills	LNB + FGR or LNB + SCR	0.4	0		1.0	0.8	800-2,960
		LNB + SCR					0.8	2,150-5,300
[redacted]								
		RACT (LNB) to Smaller Sources: Coal Oil/Gas				0.6 24.6	0.3 12.3	1,600 760-1,400
26	Residential Water Heaters	LNB	0	0		0.9	0.1	Unknown
27	Residential Space Heaters	LNB		0		0	0	0
28	Medical Waste Incinerators	SNCR	0	0		0	0	12,000
29	Municipal Waste Incinerators	SNCR	0	0		0.1	<0.1	1,000-4,000
31	Highway Vehicles and Stationary Sources	Ozone destroying paint - air handling systems, car radiators		0			0	
32	Asphalt Paving	Driveways - Non-HC Asphalt	1.6	0		0	0	N/A
33	Consumer Solvents	Driveways - Sealer Low VOC	0.16	0.01	237	0	0	N/A
34	Transportation	Land Use Planning - Promote Community Centers	66.6	1.06	17,500-19,100	105.8	0.96	--
35	Light-, Medium-, and Heavy-Duty Diesel Vehicles and Trucks	California Reformulated Diesel Program	2.8	0	N/A	11.3	0.8	$3,700-7,700
36	Light-Duty Gasoline Vehicles and Trucks	More Remote Sensing	63.8	1.2	3,340	94.5	0.6	--
37	Light-Duty Gasoline Vehicles and Trucks	Scrappage Programs	63.8	0.1	4,800	94.5	0.1	--

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
[redacted]								
39	Light-, Medium-, and Heavy-Duty Diesel Vehicles and Trucks	Emission-Based Registration Fees	66.6	2.8	18,750	105.8	8.7	--
41	All Vehicles	Eliminate Excessive Curb Idling		0	0		0	0
[redacted]								
43	All Vehicles	Smoking Vehicle Program	66.6	0.2	6,300	105.8	0	--
44	Highway Vehicles	Traffic Flow Improvements - Advanced Signal on 50 miles of Congested Arteries	66.6	0.15	21,620	105.8	0.16	
45	Highway Vehicles	Traffic Flow Improvements - CBD Signalization		0.35	125,048		0.27	
46	Highway Vehicles	Traffic Flow Improvements - Congestion/ Incident Management on Freeways		0.16	200,452		0.07	
47	Highway Vehicles	Traffic Flow Improvements - Ramp Metering		0.41	2,700		0.034	
48	Highway Vehicles	Traffic Flow Improvements - Enforce 55 mph on PA Turnpike		0.18	11,166		0.63	
[redacted]								
55	Highway Vehicles	Transit Operations - Improve Suburban Bus Service		0.07	45,356		0.10	
56	Highway Vehicles	Transit Operations - Transit First Principles		0.02	123,079		0.02	
57	Highway Vehicles	Transit Operations - Reuse of Surplus Light Rail and Trackless Trolleys		0.01	92,277		0.01	
58	Highway Vehicles	Transit Operations - Improve City Transit Division Service		0.09	42,637		0.09	
59	Highway Vehicles	Transit Operations - Philadelphia to Harrisburg Rail Service Improvements		0.01	619,774		0.03	

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
61	Highway Vehicles	Transportation Management Plans - Comprehensive Regional Ridesharing Program		0.30	10,262		0.33	
62	Highway Vehicles	Transportation Management Plans - Availability and Promotion of Average $25 Transitchek		0.12	128,691		0.14	
63	Highway Vehicles	Transportation Management Plans - Telecommuting		0.59	14,272		0.68	
64	Highway Vehicles	Transportation Management Plans - Compressed Work Weeks		0.21	11,226		0.27	
69	Highway Vehicles	Parking Management - Construct New Park and Ride Lots Along Highways		0.05	139,991		0.08	
70	Highway Vehicles	Parking Management - Expand Parking at Rail Stations consistent with [illegible] Planned Expansion	66.6	0.03	[illegible]	105.8	0.04	169,950
71	Highway Vehicles	Non-Motorized Programs and Facilities - Comprehensive Bicycle Improvements - Auto Work Trips		0.21	48,740		0.18	
72	Highway Vehicles	Non-Motorized Programs and Facilities - Comprehensive Bicycle Improvements - 14 Rail Station Trips		0.00	65,513		0.00	
73	Highway Vehicles	Non-Motorized Programs and Facilities - Comprehensive Bicycle Improvements - Non-work Trips		0.33	21,709		0.34	
74	Highway Vehicles	Emissions Reduction Programs - Removal of 50% of Pre-1980 Vehicles	66.6	0.4	57,354	105.8	0.3	
75	Highway Vehicles	Emissions Reduction Programs - Reduction in Cold Starts/Insulate Catalytic Converters		1.00	1,864		0.63	
76	Highway Vehicles	Emissions Reduction Programs - National LEV Program	66.6	[illegible]	[illegible]	105.8	[illegible]	
77	Highway Vehicles	Pricing Mechanisms - Feebate on New Car Purchase		0.28	4,393		0.17	

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
78	Highway Vehicles	Pricing Mechanisms - Gas Tax (84¢ per gallon)		5.20	(205,484)		8.70	
79	Highway Vehicles	Pricing Mechanisms - VMT Tax (4¢ per gallon)	66.6	5.20	(205,412)	105.8	8.70	
84	Highway Vehicles	Transit Operations - Grants to Non-profits to Promote Transit		0.016	52,700		0.023	35,800
91	Highway Vehicles	High Occupancy Vehicle Lanes	66.6	0.6	Very High	105.8	1.3	Very High
96	Highway Vehicles	LPG - Pilot Programs at Service Stations		2.41	11,200		1.42	
	Highway Vehicles	CNG - Pilot Programs at Service Stations	66.6	2.41	174,100	105.8	1.42	294,300
100	Highway Vehicles	Area Source Business - Credits for Alternative Fuel Vehicles			3,700-9,200			--
103	Marine Vessels	Control of Emissions (NO_x) from Ships and Ports	0	0	N/A	0	0	$10,000
104	Commercial Marine Vessels	Emission fees ($10,000 per ton NO_x)	0	0%	N/A	0	0	$10,000
105	Lawn and Garden	Emission Reduction Credits for Leaf Blowers; Electric Lawnmowers	30.1	3.0	1,200	1.3	0.1	62,000
106	Lawn and Garden	Incentives for Electric Lawnmowers	30.1	3.0	1,200	1.3	0.1	62,000
107	Nonroad	Nonroad Engine Emission Reduction Credit Programs	16.0	1.6	3,700-9,200	63.0	6.3	--
109	Aircraft	Control of Emissions from Aircraft and Ground Support Equipment	9.4	1.6	~0	10.7	0.23	$970
	Aircraft	CNG-fueled Shuttle Buses		0.01	730,200		0.05	--
	Aircraft	LPG-fueled Shuttle Buses		0.005	(207,500)		0.003	--
111	≥175 horsepower Compression Ignition (Diesel) Engines:	California Phase II Exhaust Standards and EPA Statement of Principles with Engine Manufacturers						
	Construction Equipment: Scrapers, Bore/Drill Rigs, Excavators, Cranes, Off-Highway Trucks, Rubber Tired Dozers, and Off-Highway Tractors Logging Equipment: Fellers/Bunchers		7.1	0	Unknown	43.3	0.8	Unknown

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
112	Recreational Vehicles		0.6			9.3		
	2-stroke engine category	Potential CARB Standards		0.3	60-700		0	N/A
	4-stroke engine category	Potential CARB Standards		0	60-700		0	N/A
113	Open Burning	Ban on High Ozone Days	0.23	0.18	~0	0.1	0.08	
114	Open Burning	Year Round Ban	0.23	0.18	~0	0.1	0.08	
116	All Lawn Care	Ban on High Ozone Days	30.1	11.2	0	1.3	~~0.4~~ 6.7	
118	Motor Vehicles	Voluntary "No-Drive" Measure	63.1	5.1		92.6	7.4	
119	All Sources (or a Subset)	Cap and Trade			1,000-1,800			
120	All Sources (or a Subset)	Open Market Trade			1,000-1,800			
122	Various	School-Based Public Awareness Ozone Action		4.6	101,700		7.8	--
123	Various	Promote We Care Programs to Businesses		Included in 122				
124	Various	Outreach and Education - Environmentally Responsible Behavior - Green Light		Included in 122				
126	Various	Buying Emission Reduction Credits So They Cannot be Used (NO_x and VOC)			Market Price			Market Price
127	Various	Reduce ERCs by X% per Year While They Are in the Bank (NO_x and VOC)			Market Price			Market Price
129	Highway Vehicles	Ozone Action Days Transit Strategy	66.6	1.4	25,600	105.8	2.5	
130	Non-road Spark Ignition Engines <25 hp	No Non-road SI Engines Standard Because of NO_x Disbenefit		21.0			13.0	
131	Lawn & Garden Refueling	Leakless Gas Can Nozzles	2.5	2.2	1,400-5,800	0	0	N/A
Outside Five County Area Measures								
85	Highway Vehicles	Stage II - Entire Region (Beyond 5 County)	5.0	3.3	900	0	0	
128	Highway Vehicles and Non-road	Expand Reform Gas Area to Counties North and West of Five County Area	56.0	14.8	5,800-10,300	67.0	4.0	--

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NOx		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
Demoted Measures								
6	Bulk Terminals	Vapor Recovery System						
11	Adhesives: Industrial	Reformulation and Product Substitution				0		
15	Adipic Acid Manufacturing Plants	Thermal Reduction	0			0		
16	Nitric Acid Manufacturing Plants	Extended Absorption	0			0		
		SCR						
		Nonselective Catalytic Reduction (NSCR)						
17	Cement Manufacturing	LNB SCR SNCR (Urea-based)	0			0		
30	Various	Small Business Tax Incentives						
40	Light-Duty Vehicles and Light-Duty Trucks	Eliminate Excessive Car Dealership Vehicle Starts						
49	Highway Vehicles	Transit Operations - Restore Regional Rail Service		0.01	857,915		0.02	
50	Highway Vehicles	Transit Operations - Extension of Route 66 Trackless Trolley		0.00	952,400		0.00	
52	Highway Vehicles	Transit Operations - Systemwide Fare Reductions of 10%	66.6	0.09	109,255	105.8	0.13	
53	Highway Vehicles	Transit Operations - Systemwide Fare Reductions of 20%		0.20	99,102		0.26	
54	Highway Vehicles	Transit Operations - Systemwide Fare Reductions of 50%		0.47	112,247		0.69	
60	Highway Vehicles	Transportation Management Plans - ETRP		1.80	(36,649)		2.20	
65	Highway Vehicles	Parking Management - Prohibit New Parking Facilities in CBD		Negligible Impact	Negligible Impact		Negligible Impact	
66	Highway Vehicles	Parking Management - Limit Parking Facilities at New Suburban Employment Sites		0.08	(33,728)		0.08	
67	Highway Vehicles	Parking Management - $3 Parking Surcharge		1.90	(435,912)		2.50	

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
68	Highway Vehicles	Parking Management - $3 Parking Tax in the CBD		0.47	(43,909)		0.73	
80	Highway Vehicles	Pricing Mechanisms - Double Tolls on PA Turnpike During Peak Periods		0.01	0		0.00	
81	Highway Vehicles	Emission Reduction Programs - Alternative Fuels - SEPTA	2.8	0.14 (0.61 with 42a)	229,500 (53,300 with 42a)	11.3	2.4 (4.6 with 42c)	13,550 (7,100 with 42a)
82	Highway Vehicles	Transit Operations - Reduce SEPTA Fares July-August						
83	Highway Vehicles	Pricing Mechanisms - HOV Parking Rate Incentive						
86	Highway Vehicles	Stage II - Statewide		60-70%			0	
87	Highway Vehicles	Ride Sharing						
88	Highway Vehicles	Increase Mass Transit Ridership - Parking Taxes, Market Incentives						
89	Highway Vehicles	Flat Tax on Vehicles - $200?						
90	Highway Vehicles	Build Two-Tier Highways						
92	Highway Vehicles	Traffic Flow @ 45 mph						
93	Highway Vehicles	Insulate Catalytic Converters						
94	Highway Vehicles	Promote Telecommuting						
95	Highway Vehicles	Credits for Compressed Work Week						
97	Highway Vehicles	Non-Employee Trip Reduction - Health Clubs						
98	Highway Vehicles	Buy New Engines for SEPTA - CNG, LPG						
	Highway Vehicles	Buy New Engines for SEPTA - LNG - Fleet Replacement Program	2.8	.14 (.61 with 42a)	337,000 (78,300 with 42a)	11.3	2.4 (4.60 with 42a)	19,900 (10,400 with 42a)
99	Highway Vehicles	Clean Fleet Replacement for Institutions, Large Businesses						
	Highway Vehicles	Clean Fleet Replacement for Institutions, Large Business - Light-Duty Vehicles	66.6	2.89	12,400	105.8	1.71	20,900

SE Pennsylvania Ozone Stakeholders Group
Control Measures Summary (continued)

			VOC			NO_x		
Measure No.	Source Category	Control Measure	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton	2005 Emissions tpd	2005 Emission Reduction tpd	Cost Per Ton
101	Highway Vehicles	Voluntary ETR						
102	Highway Vehicles	Alternative Fuel Vehicle - Build Fuel Stations						
108	Locomotives	Regional Railroad NO_x Emissions Reduction Measure	0.8	0%		8.2	2.9-3.5%	
110	Locomotive Engines	Potential Federal NO_x Emission Standards Potential CA NO_x Emission Standards	0.8			8.2	3.3% 6.6%	
115	Commercial Lawn Care	Ban on High Ozone Days						
117	Recreational Boating	Ban on High Ozone Days	10.9			1.1		
121	All Sources (or a Subset)	Across the Board Emission Reductions						
125	Various	Environmental Think Tank						

Notes to Accompany Control Measure Summary Table

These notes explain the analyses that were performed to estimate VOC and NO_x emission reductions and costs for measures where values were added to the summary tables since the September meeting. For a small number of measures, new information has been used to update the values in the summary table. These changes are explained in these notes. For any measure not mentioned in these notes, the summary table information has not changed.

Measures

Control Measure #5: Pressure-Vacuum Valves at Service Stations:

Information provided by the Pennsylvania DEP Regional Office (Francine Carlini) indicates that pressure-vacuum valves were installed at service stations in the five county area when stage II vapor recovery systems were installed. Thus, no additional VOC emission reductions are available via measure #5 after 1996. The 1996 and 2005 baseline forecasts will be revised to include these emission reductions.

Control Measure #8: Rule Effectiveness (RE) Improvements:

At the September meeting, the stakeholders requested that the potential emission reductions from improving RE to 100 percent be quantified. This analysis was performed by using the 1996 assumptions from the Philadelphia rate-of-progress plan about RE improvements since 1990, and applying 100 percent RE for all point sources.

No cost has been estimated for these RE improvements because of the variety of source types and control equipment affected. This analysis shows that the potential VOC emission reductions from 100 percent RE are 21.7 tpd. Most of this VOC reduction, 16.4 tpd, is observed from solvent utilization - surface coating.

Any RE improvements are not expected to affect NO_x emissions because (1) NO_x emissions were mostly uncontrolled in 1990, and (2) many of the RACT or OTC NO_x MOU affected sources will have continuous emission monitors, which will ensure full compliance by these units.

Control Measure #31: Prem Air Catalysts

The South Coast Air Quality Management District (SCAQMD) 1997 Air Quality Management Plan contains a control measure to encourage the incorporation of catalyst surface-coating technologies in *residential and commercial air conditioning units*, in order to promote the conversion of ground-level ozone and carbon monoxide into oxygen and carbon dioxide. To maximize air quality benefits, this control measure would be primarily implemented in those areas within the South Coast Air Basin that experience the highest ambient ozone levels.

Because this technology does not affect emissions of ozone precursors, the listed emission reductions in the control measures summary table are zero.

Control Measure #32: Driveway Asphalt - Non-VOC Asphalt

The substitution of emulsified asphalt for cutback asphalt reduces VOC emissions by 100% because true emulsified asphalt contains no VOC. The total of the five county emission estimates for this SCC are 1.6 tpd. Because driveway asphalt paving should be covered by the PA regulation (129-64) that prohibits cutback asphalt use in the ozone season, the estimated emission reductions are zero for this measure.

The major cost associated with control of VOC is the price difference between cutback and emulsified asphalt. The cost effectiveness is estimated to range from a $73 savings to a $15 cost per ton of VOC.

Control Measure #33: Driveways - Low VOC Sealers

Control Measures and Costs

These sealers fall under the source category of bituminous coatings as described in the architectural coating rules proposed by the US EPA. By definition, bituminous coatings also include coatings formulated and recommended for roofing, pavement sealing, or waterproofing. This coating category is intended for regulation in the VOC Architectural and Industrial Maintenance (AIM) Coating Emissions Proposed Rules scheduled to go into effect on January 1, 1998. The new rules are expected to set the maximum allowable amount of VOC in any bituminous coating to 500 g/L.

An industry survey concluded that few commercially available bituminous coatings contain more than 500 g/L and therefore most are compliant with the proposed standard as currently formulated. It is estimated that a reduction of less than 0.01 tpd in VOC emissions is expected by adopting the National Architectural and Industrial Maintenance coating rule as currently proposed. EPA estimates the AIM rule will have a nationwide cost-effectiveness of $237 per ton of VOC. It has also been suggested (AQMP, 1997) that the cost effectiveness associated with requiring the use of zero VOC formulations would be $12,270/ton of VOC reduced.

Emissions

VOC emissions from bituminous coating are estimated in the 5 county area to be 0.16 tpd. This estimate is based on the Architectural and Industrial Maintenance survey (AIM) (Report to Congress, March 1995) which determined that bituminous coatings contribute nationally 0.54% of the VOCs of surface coatings. The total VOC emissions of surface coatings in the 5 county region is estimated as the sum of architectural coatings, traffic markings and special purpose coatings (SCC 24-01-001-000, 24-01-008-000, 24-01-201-000, respectively) and are 28.7 tons of VOC/day (0.54% x 28.7 tpd = 0.16 tpd).

Control Measure Number #34: Land Use Planning - Promote Community Centers

This longer-term strategy assumes that municipalities will choose to pass local ordinances and zoning amendments that will promote walking, biking and transit use and discourage single occupancy vehicle.

Chester County Example:

Emissions Benefits (Tons per Day):	VOC: 0.20	NO_x: 0.17
Cost per Ton:	VOC: $34,800	NO_x: $42,400
	Combined: $19,100	

Philadelphia County Example:

Emissions Benefits (Tons per Day):	VOC: 0.96	NO_x: 0.79
Cost per Ton:	VOC: $31,800	NO_x: $38,700
	Combined: $17,500	

Program commitments for land-use projects are frequently results-oriented rather than strategy-specific, and often include "packages" of linked or supporting strategies. Techniques for achieving the results vary, and are described in the reports cited below. The techniques may include short-range changes such as parking pricing, rideshare incentives, and guaranteed ride home, plus longer-range strategies such as sidewalk and path improvements, zoning changes to encourage higher density and mixed use development, and/or limitations on parking for new developments.

For example, the Silver Spring district establishes goals of "maximum PM peak hour out-bound vehicle travel", "percentage of all commuters using transit in peak periods", and "average vehicle occupancy rate of commuters arriving by car or van in peak periods" or "percentage of non-drivers in peak periods". All employers with more than 25 employees are required to participate and commit to specific efforts such as appointing transportation coordinators. New developments must commit to achieving higher levels of ride-sharing and/or transit use; the district provides extensive support such as ride-share matching.

A separate study (cited below) identifies performance goals in terms of specific ranges of vehicle trips and VMT per person and per household, as well as mode share of person trips into auto-driver and other. The performance goals, developed primarily from California experience, vary depending on type of community (urban, suburban, and exurban), with three levels of achievement within each community type.

Key Assumptions:

- The analysis assumes (for example purposes only) that municipalities in Chester County and Philadelphia County decide to commit to specific targets of vehicle trip reductions and implement multi-faceted programs of ordinances and marketing to achieve the same.
- The Chester County example assumes that drive-alone work trips are reduced from 78.7 percent of total trips to 75 percent of total trips. (Note that the CARB study suggests a performance maximum of 70 percent for auto driver trips, which includes carpool trips- another 11.2 percent of trips in Chester County.)
- The Philadelphia County example assumes that drive-alone and carpool trips, currently at 59.5 percent of total work trips, are reduced to 55 percent. (The CARB study identifies 55% as the lowest level for an urban community, with level 1 at 40 percent.)

- The cost estimate is based on the Silver Spring Transportation Management District budget of $338,000 divided by 250 work days divided by estimated work trips to identify a cost per work trip per day, multiplied by the work trips in Chester and Philadelphia counties.

Data Source(s)/ contacts:

"Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions- an Indirect Source Research Study", California Air Resources Board;

Silver Spring Transportation System Management District Annual Report, 1995 (Montgomery County, Maryland);

1995 Commute Trip Reduction Results in King County, Fotini Georgiadou, February 1996 (Washington state); plus an unpublished paper from same source.

Control Measure #39: Emission-Based Registration Fees

At the August stakeholders meeting, it was decided that a Philadelphia-specific analysis of this measure was not warranted. Therefore, the analysis of the magnitude of potential emission reductions associated with the imposition of emission-based fee programs is based on an analysis of the Baltimore metropolitan area with a fee structure independent of age considerations. Under such a scenario, older, inherently higher emitting vehicles would receive no special allowances and a gram of emissions from one vehicle would be equivalent to a gram from another, regardless of vehicle-to-vehicle differentials. Differences in mileage accumulation are considered in the fee structure, however.

The analysis performed with the EFEE model for Baltimore showed that in the year 2005, a $100 VOC plus NO_x emission fee would result in a 4.5 percent reduction in light-duty vehicle (LDV) VOC emissions and a 9.4 percent reduction in LDV NO_x emissions.

Estimating the cost effectiveness of emission-based fee programs requires an estimation of the residual values of vehicles scrapped in response to the program, an estimation of the incremental repair expenditures prompted by the program, and an accounting method to aggregate expenditures across model years. For the purposes of this evaluation, program cost effectiveness was estimated using an incremental program cost of $76, which is $100 per vehicle minus the current annual Pennsylvania registration fee of $24. This $76 annual cost is equivalent to a daily charge of 20.8 cents per day. If the charge and benefit are used for LDVs, a combined VOC plus NO_x benefit in 2005 of 10.61 tons per day with a charge of $198,974 for 0.95 million affected vehicles yields a cost effectiveness of $18,750 per ton.

Control Measure #41: Eliminate Excessive Curb Idling

Limit idling time to three minutes through ordinances and enforcement.

Emissions Benefits (Tons per Day):	VOC: 0	NO_x: 0
Cost per Ton:	VOC: 0	NO_x: 0
	Combined: 0	

California proponents (CARB and others) have discussed this measure for some time, including the more easily enforced but hard to implement option of limiting or eliminating drive-in banking and other drive-in services such as restaurants (primarily fast food places). The state backed away from recommending such measures on a statewide basis, leaving them to municipalities to enact and enforce. To date there is no known municipal ordinance or enforcement program in California on curb idling. General curb side idling was determined to be next to impossible to enforce.

New York efforts concentrated on heavy duty vehicles, however the numerous exceptions (the vehicle operator is allowed to leave the motor running if needed to operate a lift or other power equipment, for example) also made enforcement difficult.

The trade-off between idling and a new start may be problematic: NO_x is not emitted while idling, and the VOC benefit typically accrues at three to five minutes; prior to that time there is greater emission from a new start than from idling. The benefit varies greatly depending on the age of the vehicle. Enforcement again becomes problematic: ticketing for excessive idling might actually increase emissions if people start and re-start engines for wait times of less than three minutes.

It is anticipated that the break-even time for idling versus a hot start will decrease to approximately 2 minutes after the year 2000 with the changes in automobile technology.

Key Assumption: Curb idling efforts in states such as California with strong environmental programs have not successfully implemented curb idling limitations, as discussed above. At certain idling times enforcement can worsen emissions, making analysis very tenuous. It does not appear to hold promise for Philadelphia.

Data Source(s)/ contacts: Jeff Long, CARB, 818-450-6140

Control Measure #84: Transit Operations - Transit Chek to Non-Profits

Provide Grants to Non-Profits to Promote Transit (via Transit Chek).

Emissions Benefits (Tons per Day):	VOC: 0.016	NO_x: 0.023
Cost per Ton:	VOC: $52,700	NO_x: $35,800
	Combined: $21,300	

Currently there are 25 non-profit agencies participating in the Transit Chek program, representing 418 employees. Many non-profits participate in the program, without a tax break, as the program represents a socially responsible action and also supplements often meager fringe benefit packages for employees. Note that government agency participation in the program dwarfs the non-profits, with 20 employers and 4,204 employee participants, including 2000 in the Philadelphia US IRS.

Key Assumptions:

- Assumes that current Transit Chek riders represent 10 percent of their agency populations (a guess). Uses the CMAQ methodology assuming a high-intensity employer program.

- Assume $20 per employee per month pass-through grant, also to be given to current participants.

- New share of employees in program increases to 20 percent.

- No additional administrative cost implied: program cost represents pass-through only.

Data Source(s)/ contacts: Susan DiDomenico, DVRPC

Control Measure #96: LPG - Pilot Programs at Service Stations

Initiate programs to install LPG (propane) refueling capabilities throughout the Philadelphia area, to increase the public use of LPG (versus fleet operations).

Emissions Benefits (Tons per Day):	VOC: 2.41	NO_x: 1.42
Cost per Ton:	VOC: $38,200	NO_x: $64,600
	Combined: $24,000	

Increasing the acceptability of alternative fuel vehicles to the general public, beyond their use in centralized fleets, will likely require a network of geographically dispersed and recognizable fuel stations for each alternative fuel to be marketed.

Key Assumptions:

- LPG-fueled private vehicles to be driven 12,500 miles per year.

- Stations equipped for LPG to fuel 25 LPG vehicles per day.

- The anticipated capital cost for each fueling station is $79,000, and the cost to equip each car for LPG is $3,000. Station cost is amortized for 10 years, vehicle cost for 5 years.

- The operating fuel cost differential per mile is a savings of $.0059, based on U.S. Department of Energy Assessment (cited below). Note that Sunoco materials provided to stakeholders estimated a $.07 additional fuel cost per mile. The fuel savings assumption is key to the low cost per ton identified above.

- The emissions tonnage assumed is based on 20,000 private vehicles equipped with LPG, serviced by 800 stations in the region.

- No assumption is made as to who bears the cost of refitting vehicles or stations-whether government entity, private citizen or individual station owner.

Data Source(s)/ contacts:

Sunoco handout to Stakeholders.

Battelle *"Clean Fleet" Final Report.*

Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: a 2000/2010 Analysis. US Department of Energy, January 1996, page C-39.

Control Measure #105: Emission Reduction Credits for Leaf Blowers, Electric Lawnmowers

The NESCAUM Emission Reduction Credit Summer Program has developed a protocol for determining VOC and NO_x emission reduction credits associated with switching from gasoline to electric powered lawnmowers.

In the SCAQMD, Rule 1623 provides opportunities to generate NO_x, VOC, CO, and PM mobile source emission reduction credits that can be used as an alternative means of compliance with regulations, as well as promote the purchase of low-polluting equipment and early retirement of older, high polluting equipment. Under the South Coast rule, people, or organizations, can generate credits by (1) replacing existing lawn and garden equipment or (2) direct sale of new low or zero emission equipment. Actions require a minimum of 100 units of lawn and garden equipment replaced or sold.

Credit lifetimes vary based on the equipment type (from as little as one year for commercial chain saws to seven years for electric lawnmowers in residential use). Retired engines are made inoperable by drilling a hole through the engine block.

Annual credits per unit for residential equipment by type of lawn and garden equipment (lbs/year) are listed below as an example.

	Zero Emission Equipment			
Lawnmowers	**VOC**	**NO_x**	**CO**	**PM**
4-Stroke	3	0.1	24	0
2-Stroke	13	0	27	0.4

Control Measure #106: Incentives for Electric Lawnmowers

During the spring and summer of 1995, the Maryland Department of the Environment implemented Cash-for-Clippers, a lawn and garden equipment trade-in program. Through Cash-for-Clippers, Maryland provided $75 rebates toward the purchase of environmentally friendly (electric or push mowers) lawn equipment to individuals who scrapped their gasoline-powered equipment. For hand-held equipment, the rebates were $25.

Now that cordless, electric lawnmowers are available in the marketplace, their market penetration depends on their cost relative to gasoline-powered mowers (as long as their performance is perceived to be the same as a gasoline-powered mower). Cost effectiveness calculations are based on residential use replacement, and that the rebate amount ($75 for lawnmowers) is about equal to the price difference between electrics and gasoline-powered mowers.

Rebates are assumed to be most effective in the residential market because a 90 minute charge is enough to mow most residential lawns. Electrics cannot meet commercial need for full-day operation. Emission reductions are based on 10 percent market penetration by 2005 of battery-powered lawn and garden equipment.

Control Measure #107: Nonroad Engine Emission Reduction Credit Programs

This proposed measure would provide opportunities to generate NO_x, VOC, CO, PM, and SO_2 mobile source emission reduction credits that can be used as an alternative means of compliance with regulations. These credits would be generated based on voluntary emission reductions created by the operation of low or zero emission off-road equipment within the nonattainment area that result in emission reductions beyond those required by Pennsylvania regulations.

A similar measure was adopted as Rule 1620 - Credits for Clean, Off-Road Mobile Equipment by the SCAQMD effective January 1, 1996. Rule 1620 applies to any off-road mobile equipment or vehicle for which emission standards have been adopted by EPA or CARB. The equipment and vehicles subject to this rule are used primarily off the highways to propel, move, or draw persons or property in construction, commercial, industrial, mining, agricultural, or forestry applications within the nonattainment area, and include equipment such as dozers, loaders, tractors, scrapers, graders, off-highway trucks, forklifts, and utility service vehicles. Rule 1620 does not apply to utility and lawn and garden equipment, off-road motorcycles, all-terrain vehicles, go-karts, golf carts, marine vessels, aircraft and locomotives.

With little evidence about the cost effectiveness of nonroad engine replacement and retrofit programs, the cost per ton estimates for this measure are those estimated by CARB for accelerated scrappage programs for light-duty vehicles.

Control Measure #109: Aircraft LTOs and Ground Support Equipment

In order to develop cost estimates for this measure, we diverged from the airport cap approach used previously (there are too many options available under this approach to develop comprehensible estimates). We revised this control measure to include a control measure for aircraft emissions and a control measure for ground support equipment (GSE).

Measures that are targeted for aircraft are more problematic than for those targeted at GSE (e.g., safety concerns due to changes in the operation of aircraft). One measure in the 1994 EEA report to CARB that appears less problematic than the others is Single/Reduced Engine Taxiing. This measure is implemented by having aircraft use only one or two of the available engines (where this can be done) to taxi the aircraft after landing and prior to takeoff. It also requires that aircraft spend less time taxiing (especially during taxi out).

EEA (1994) provided some estimates for emission reductions, however these apply to LAX and to only one type of aircraft (Boeing 737-300). Hence, the applicability to Phil. Int. Airport is highly uncertain. EEA also suggested that the control measure be assumed to apply only 70% of the time (apparently to handle various operational contingencies). Based on the limited data, emission reductions would be 15% for VOC (70% of 22% control effectiveness) and 2% for NO_x (70% of 3%). Emission reductions for the NAA in 2005 would then be 1.41 tpd VOC and 0.21 tpd NO_x. According to EEA (1994), the control measure would produce a small cost savings due to lower fuel usage. No other data were given on cost.

The proposed measure for GSE is conversion to CNG/LPG. Emission estimates for the NAA were estimated with data in EEA's 1995 Technical Support Document (TSD) for the FIP rules. Assuming that the ratio of emissions for GSE to aircraft is similar between Phil. Int. Airport (PIA) and the airports in Southern CA: VOC = 9.42 tpd x 0.053 = 0.50 tpd; NO_x = 10.7 tpd x 0.102 = 1.09 tpd.

Also from data in EEA 1995, it is assumed that all GSE engines are >50HP and that there is a 30% Diesel/70% Gasoline ratio. Average emission factors using these assumptions are 3.16 g/bhp-hr VOC and 6.10 g/bhp-hr NO_x. The emission factors for CNG/LPG are 2.0 g/bhp-hr VOC and 6.00 g/bhp-hr NO_x. Emission reductions based on these factors are 37% for VOC and 1.6% for NO_x. The associated 2005 emission reductions are 0.19 tpd VOC and 0.02 tpd NO_x.

Costs were estimated by assuming that a typical retrofit would cost $2,500 (EEA, 1995). An example unit (175 HP diesel engine) was used to determine typical annual emission reductions for the retrofit (0.42 tpy NO_x). Assuming a 10 year equipment life, annualized costs are $408/yr. This yields a cost effectiveness of $970/ton.

Control Measure #109A: Control of Emissions from Aircraft and Ground Support Equipment (mobile sources portion of analysis): CNG-fueled Shuttles

Identify means to reduce emissions for vehicles on roadways involved in airport activities. The identified strategy substitutes alternative fuel vehicles for the vans and buses that transport employees and passengers from remote parking lots to terminals.

Emissions Benefits (Tons per Day):	VOC: .01	NO_x: .05
Cost per Ton:	VOC: $2,717,100	NO_x: $1,625,600
	Combined: $730,200	

Clean fuel shuttle buses are in use in Baltimore-Washington International Airport and other locations around the country. Shuttle operations, with limited range requirements and centralized fleet characteristics, can be a good application for alternative fuel technologies. In this instance, the small number of buses and vans, the high cost of a dedicated refueling facility, and the cost differential in fuel cost per mile create an uneconomical option.

Key Assumptions:

- Sixteen buses serving the airport employee lot and long-term parking lot are replaced with CNG vehicles on a replacement cycle basis, incremental cost of $9,000 per bus based on California school bus bids. Buses amortized for 10 years.

- Fifteen vans (assumed number based on number of rental companies, number of trips and proximity to airport) are replaced with CNG-fueled vans, incremental cost $4,000 per van, 8 year amortization.

- Fuel cost differential estimated at $.165 per mile for buses, $.13 per mile for vans. Buses combined operate approximately 3,000 miles per day, vans approximately 2,000 miles per day, based on data received.

- Freight support vehicles such as UPS and FedEx are examined separately under Measure 99, "Clean Fleet Replacement".

- General ridesharing and similar programs will target airport employees and possibly riders; does not include benefits for a targeted airport rideshare program.

Data Source(s)/ contacts:

Robert Molle, Philadelphia International Airport, response to request for information including vehicle classification counts from December, 1992.

Alternative Fuel Transit Buses, US Department of Energy, May 1995.

Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: a 2000/2010 Analysis. US Department of Energy, January 1996, page C-39.

EPA Special Report: Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Volume II Heavy Duty Vehicles, EPA April 1990.

Control Measure #109B: Control of Emissions from Aircraft and Ground Support Equipment (mobile sources portion of analysis): LPG-fueled vans for rental car company shuttles

Substitute propane-fueled vehicles for the vans that transport passengers from rental car lots to terminals and vice versa.

Emissions Benefits (Tons per Day):	VOC: .005	NO_x: .003
Cost per Ton:	VOC: ($24,200)	NO_x: ($40,900)
	Combined: ($15,200) (all cost savings)	

Shuttle operations, with limited range requirements and centralized fleet characteristics, can be a good application for alternative fuel technologies. In this instance, the lower cost of propane (based on the DOE study) indicates that an option that reduces emissions can also reduce costs. Cost effectiveness is greatly influenced by the fuel cost. However, the small number of vehicles and miles generates very little VOC and NO_x savings.

Key Assumptions:

- Incremental vehicle cost $3,000, amortized for 8 years.
- Fueling station cost $79,000, amortized for 10 years.
- Fuel cost savings of $.0059 per mile (conventional gasoline vs. propane).

Data Source(s)/ contacts:

Robert Molle, Philadelphia International Airport, response to request for information including vehicle classification counts from December, 1992.

Sunoco handout to Stakeholders.

Battelle *"Clean Fleet" Final Report.*

Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: a 2000/2010 Analysis. US Department of Energy, January 1996, page C-39.

Control Measures #113 and 114: Open Burning Bans (Ozone Action Day or Year Round)

Commercial, institutional, and industrial open burning is already prohibited in the area. Some municipalities also ban residential open burning. An areawide ban on residential open burning would provide relatively modest emission reductions as emissions from open burning are already low. Base year emission estimates assume 80 percent rule effectiveness for the existing open burning prohibitions.

Control Measure #116: Lawn Care - Ban On High Ozone Days

This control measure involves banning the use of lawn and garden equipment on Ozone Action Days. This ban could either be on all lawn and garden equipment use, or just residential (homeowner) use. Because the stakeholders seemed to be primarily interested in a residential use ban, the emission reductions in the summary table are for that situation. All emission credits computed for this measure assure 80 percent rule effectiveness.

It is estimated that VOCs could be reduced by 11.2 tons per day via a residential use ban, and 24.1 tons per day, if both residential and commercial lawn equipment could not be used on high ozone days. No cost is attributed to a residential ban, as lawn mowing is just delayed by up to a few days. The foregone revenue attributable to a commercial ban was estimated to be $1.5 million per day based on 10,000 commercial walk-behind mowers used 8 hours per day for a $20 per hour charge. This probably overestimates actual losses. The cost effectiveness of the commercial ban would be $116,000 per ton of VOC based on these figures.

Control Measure #118: Voluntary No Drive

Estimates of emission reductions and costs are taken from the Sacramento 'Spare the Air Program'. The Cleaner Air Partnership of Sacramento performed surveys of drivers in the Sacramento area following two separate ozone episodes this past summer. The goal was to gather data to describe changes in driving behavior following the use of both radio and television ads asking drivers to reduce their driving, wherever possible.

Judith Lamare of the American Lung Association provided the following estimates from the survey results.

VOC and NO_x reductions = 7.3 tpd
Estimated 1995 light-duty inventory = 93 tpd
Percent control = 8%

2005 light-duty emissions in the Phil. NAA are 92.55 tpd NO_x and 63.05 VOC. Total precursors are 156 tpd. Assuming the same 8% reduction, the 2005 emission reductions for Phi. would be 12.5 tpd (a breakout of NO_x versus VOC was not provided).

Costs for the Spare the Air Program were provided by Sacramento Metropolitan Area AQMD. These amounted to about $150k in 1996. Approximately 2.5 staff people are needed during the summer ozone season. Assuming that there are about 30 ozone episode days per year, the annual emissions reduced in Sacramento would be 219 (VOC and NO_x). The cost effectiveness based on the advertising costs and the annual emission reduction estimate is $685/ton.

Control Measures #119 and 120: NO_x Trading Programs

EPA proposed a model Open Market Trading Rule that establishes a mechanism for emissions trading among sources contributing to ground-level ozone levels. In a study conducted by Pechan in 1996, the costs of NO_x emission reductions under the Open Market Trading Rule were estimated for three sample nonattainment areas (Atlanta, Houston, and St. Louis). The trading rule included all major sources, and RACT controls were incorporated into the baseline. Two separate target reductions were evaluated in each NAA, and costs per ton were estimated for 1996 and 1999. The following two regulatory alternative scenarios were modeled: 0.15 lbs/MMBtu and 0.33 lbs/MMBtu. In 1999, the analysis estimates a cost of reducing NO_x under the 0.15 lbs/MMBtu scenario ranging from $1,020 to $1,760 per ton, depending on the NAA and reduction target. The 1999 cost of reducing NO_x under the 0.33 lbs/MMBtu scenario ranged from $630 to $1,430 per ton. These costs are relative to a 1990 baseline, so the incremental cost from Phase 1 (RACT) control levels may be higher.

Control Measures #122, 123, 124: School-Based Public Awareness Ozone Action; Promote We Care Programs to Businesses; Outreach and Education - Environmentally Responsible Behavior - Green Light; Environmental Think Tank

General widespread public information programs to increase public awareness and sensitivity to ozone problem.

Emissions Benefits (Tons per Day): VOC: 4.6 NO_x: 7.8
Cost per Ton: VOC: $273,700 NO_x: $161,800
Combined: $101,700

A well-marketed, multi-faceted education program, developed and reinforced through repetition over a number of years, can effect a change in behaviors. Examples such as anti-littering campaigns of several decades past, and more recently the emphasis on recycling, demonstrate effectiveness of public education over time. Some cities, with histories of such programs, are developing indicators of effectiveness. However, the methodologies are generally subjective rather than objective, and it is difficult to separate the variables of cleaner cars and other actions. Further, the "science" of predicting an ozone "event" is still in development; and evading an "event" may include many variables, in addition to the public information campaign. Quantification is problematic, but has been attempted based on a Sacramento survey and study.

Key Assumptions:

- Program budget estimated at $.30 per capita based on CMAQ transit marketing guideline. (May be understated. Sacramento full program approx. $.46/capita).

- Action effectiveness based on Sacramento 1995 follow-up surveys to Ozone Action program marketing efforts. Note that the Sacramento program has been in effect since 1989. Survey results applied to the Philadelphia service area for the analysis are as follows:

  - Philadelphia service area population: 4.2 million
  - Percent noticing Air Quality Index on most or all days: 25% (Sacramento)
  - Percent indicating that it was "possible" or "somewhat possible" to reduce trips on a given day: 51% (Sacramento as basis for following percentages.)
  - Number of respondents indicating that their general travel habits had changed to include transit (2%), to carpool (7%) or to consolidate or reduce trips (15%): combined 24%. Note that in the Sacramento study much higher percentages (over 60 percent) indicated that they had changed some sort of behavior on an ozone action alert day- such as staying home, not exercising, or driving less (all reported at about 60 percent).
  - The sequential discounting calculates to 3% of the service area population changing their behaviors on an ozone action day.
  - Trips reduced per person taking action (per study): 3.76
  - Mean trip distance- all trips (Philadelphia County): 9.78 miles. Most estimated to occur off-peak, e.g., afternoon trips deferred, etc.
  - Average vehicle occupancy 1.1
  - Total yield 4,256,800 VMT.

- Caution should be used in relying on self-reports after the fact. Survey results have not been confirmed by vehicle counts or other objective measures.

Data Source(s)/ contacts:
A nationwide EPA study is underway to review periodic measures and establish guidelines for inclusion in conformity plans. The data are not ready for release, but Sacramento was identified as an agency with comprehensive data.

The Cleaner Air Partnership 1995 Public Opinion Survey on Air Quality and Transportation, Sacramento, CA

A Time to Clean Up The Air: The Clean Air Partnership's Public Education Plan on Air Quality and Transportation, December 1994, Sacramento, CA.

Control Measure #128: Expand Reform Gas Area

The stakeholders asked that the OTAG mobile source matrix of phase II control options costs be incorporated in the Southeast Pennsylvania analysis. This data source lists Federal RFG-Phase II costs of 6.7-11.9 cents per gallon. The OTAG matrix also lists a combined NO_x plus VOC cost per ton of $3,500 to $6,200.

For this analysis, the estimated emission benefits in the four counties west and north of the Philadelphia ozone nonattainment area were used to estimate a cost effectiveness range with the OTAG fuel costs. This cost per ton range (combined VOC plus NO_x) was $5,800 to $10,300 per ton.

Control Measure #129: Ozone Action Days Transit Strategy

Multi-pronged effort to encourage transit use on ozone action days.

Emissions Benefits (Tons per Day):	VOC: 1.4	NO_x: 2.5
Cost per Ton:	VOC: $71,800	NO_x: $39,800
	Combined: $25,600	

This measure includes three separate strategies suggested by SEPTA to be implemented simultaneously on ozone action alert days. (Program marketing and administration costs are not included in program estimates).

1. Free transfers. Transfer charge is $.40, approximately 40 percent of patrons must use transfers or pre-paid pass. 80,000 per day pay for transfers.
2. Free companion for passholders. Approximately 70,000 passes are now in use.
3. Extend transit checks, particularly to large employers, as ozone action day specials for employees; particularly $15 lowest cost pass, good for approx. 6 regular round trip fares, or 2 round trip rail fares.

By comparison, Cincinnati implemented a $.50 flat fare program for the entire summer, supplemented with a federal grant, and experienced a 13 percent increase over regular ridership.

Key Assumptions:

- An additional 40,000 will be attracted by free transfers.
- 25% of pass holders will bring a companion.
- Transit cheks, marketed to large employers, will increase five-fold.

- Net gain in new riders is 139,400 or a 3.3 percent increase over current average riders. Note that two years ago on a "Try Transit" Day, with $1 regular, $2 commuter rail fare, SEPTA attracted almost 10 percent more passengers than average. Further, SEPTA can accommodate up to 10 percent more passengers during summer months without adding capacity. These figures may be conservative, depending on public reaction and marketing.

- Change in VMT approximately 1.4 million miles.

Data Source(s)/ contacts: John McGee, SEPTA
Nancy Core, Cincinnati METRO.

Control Measure #131: Leakless Gasoline Can Nozzles

This measure involves using vapor recovery nozzles to control refueling emissions from the refueling of lawn and garden equipment. Special nozzles are available with an automatic stop device. These inexpensive devices are available at many hardware stores. They work by keeping the gasoline from pouring until the nozzle is inserted in the tank, stopping flow automatically when the tank becomes full, and sealing the container when the nozzle is removed from the tank.

Nozzles that fit fuel containers of 2 1/2 gallons or less cost $4.89, while nozzles for larger capacity containers cost $12.49. For a small nozzle in typical residential use, the cost effectiveness of the vapor recovery nozzle is $1,400 to $5,800 per ton of VOC depending on the gasoline quantity used during the summer season. Because the nozzle provides fuel savings, more gasoline usage produces a lower cost per ton. In commercial use, fuel savings outweigh the nozzle cost, so the cost effectiveness is a savings of $130 to $290 per ton.

MEASURE NO. 1
SOURCE CATEGORY Industrial Surface Coating
CONTROL MEASURE Add-on Controls or VOC Content Limits

DESCRIPTION

This control measure calls for more stringent VOC limits on surface coating for several industrial surface coating source categories (including industrial adhesives). Included are both point and area wood surface coaters, can coating, miscellaneous metal parts, plastic/rubber/glass parts, fabric/paper, vinyl coating, coil coating, metal furniture/appliances, and industrial adhesives. The proposed rule would amend the existing state rule (PA Title 25 Chapter 129.52) to require more stringent limits on VOC content for coatings from the above sources. The new limits are based largely on either existing SCAQMD limits (SCAQMD, 1993) or CARB RACT/BARCT guidance (CARB, 1992a,b).

For auto body painting (new vehicles) and magnet wire coating, no other VOC limits were identified that were more stringent than the existing PA limits. For can coating, the new limits are based on SCAQMD Rule 1125. For coil coating, the limits are based on CARB RACT/BARCT (CARB, 1992a). For fabric, vinyl, and paper coating, the limits are based on SCAQMD Rule 1128. For metal furniture, large appliances, and miscellaneous metal parts, the limits are based on CARB's RACT/BARCT. For wood furniture, the limits are based on SCAQMD Rule 1136. This control measure also calls for the implementation of RACT on area sources conducting wood furniture coating.

Depending on the specific product involved (e.g., top coat, primer) the VOC limits will be reduced by following approximate values (ranges): Can coatings - 0-33%; Coil Coatings - 35%; Fabric, Vinyl, Paper coatings - 24-41%; metal furniture, appliances, misc. metal parts - 19-47%; wood furniture - 16-34%. For CTG-limits applied to area sources, the estimated VOC limits are up to 55% lower for wood furniture coatings (hydrocarbon-based coatings versus water-based coatings).

1. VOC Content Limits/Add-on Control Equipment for Industrial Surface Coating
COST
Capital Cost N/A Operating and Maintenance Cost N/A Annualized Direct Costs N/A Administrative Costs/Issues Recordkeeping and possibly reporting requirements will be needed to establish compliance. Therefore, additional administrative costs will be

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

Estimates are 0 to 90 percent control depending on the stringency of the VOC limits for other programs and the existence of CTG/state limits. Estimates are made based upon the differences in VOC limits even though other aspects of the measure could affect control efficiency (e.g., higher transfer efficiency equipment, lower VOC clean-up solvents).

Wood furniture: Point Sources - Controlled to SCAQMD 1997 limits from existing state limits (30%).
Area Sources - Controlled to CTG/state limits from currently uncontrolled limits (32%).

No more stringent levels were identified than the current state limits for either Auto Body or Magnet Wire coating (0%).

For the remaining categories estimates are from a comparison of state limits (if they exist) versus CARB RACT/BARCT and/or SCAQMD Rule limits: Can Coating (25%); Misc. Metal Parts (30%); Plastic/Rubber/Glass (60%); Fabric/Paper (40%); Cal Coating (35%); Metal Furniture/Appliances (20%); Industrial Adhesives (90%).

Applicability - how many sources, their size

This measure applies to all sources that consume more than 1 gallon of coating per day.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

VOC only: Assuming coverage of all sources, a minimum of 12.3 tpd in 2005 is expected. Additional reductions are likely from some of the other coating-related categories in the inventory (General Coating, Thinning Solvents, Other).

Permanence

Measurable

Through recordkeeping and reporting requirements, emission reductions could be measured and verified.

Availability

Emissions are assumed to be available for reduction.

COST-EFFECTIVENESS - Most costs were taken from RACT/BARCT reports or the SCAQMD 1994 Air Quality Management Plan. For categories with no available costs, a conservative (high) estimate of $4,000 - 5,000/ton is assumed based on the range of reported costs for the other categories. However, for categories with existing VOC limits, the costs for adoption of more stringent limits may be much lower than the assumed amount, since no new equipment is generally needed (e.g., spray guns).

IMPLEMENTABILITY

Enforcement

Enforcement could be implemented through recordkeeping/reporting requirements.

Ease of Determining Compliance

There is already a requirement for daily recordkeeping in the state rule. Hence, there would not be a significant incremental compliance burden on sources and the implementing agency. The recordkeeping requirement applies to all sources, regardless of size. Hence, even the wood furniture area sources should not be significantly impacted with a recordkeeping requirement.

Implementation Ease

Several States already have low-VOC coating regulations in place (most notably, California). Hence, for the affected categories, the measure is not expected to be technology-forcing.

Timing of Reductions

All VOC limits in the CA rules occur by the year 1997, although most are already in place. Assuming the rule was put into effect by 1998, reductions would occur in 1999.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Due to the fact that there are other state or local rules already in affect, there should not be any significant issues regarding political acceptability.

Consensual

Voluntary   Who Pays - Fairness From the inventory, the only sources that appear to be largely unaffected by the proposed control measure are area sources conducting can coating. These sources are expected to emit about 7.9 tpd in 2005. Therefore, if RACT-level limits were established for these sources, an additional 2.0 tpd in reductions could be garnered. Location The rule applies to all sources in the five county area.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Some VOC HAPs are likely to be reduced along with the VOC emissions. If increases in transfer efficiency take place, reductions in PM (from overspray) may also occur. Secondary Benefits - materials, agricultural, tourism, land use, etc. With higher solids formulations and transfer efficiency, less material (paint and thinners) will be consumed. Secondary Costs - energy, etc. None known.

MEASURE NO. 2
SOURCE CATEGORY Surface Coating - Aerospace
CONTROL MEASURE Extend VOC Content Limits to Small Facilities

DESCRIPTION

2. Extend VOC Content Limits to Small Facilities Performing Aerospace Surface Coating
COST
Capital Cost N/A Operating and Maintenance Cost N/A Annualized Direct Costs N/A Administrative Costs/Issues Costs N/A. . Additional administrative burden due to the reporting and recordkeeping requirements associated with coating rules for the smaller sources.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels For point sources, no reductions are assumed, since these sources will be covered by the MACT standard. For area sources, a 60% reduction is assumed based on MACT/SCAQMD level VOC limits and operating practices. Applicability - how many sources, their size As per SCAQMD Rule 1124, the requirements apply to the following industries: commercial and military aircraft, satellite, space shuttle and rocket manufacturers and their subcontractors. The rule does not apply to facilities that use less than 3 gallons of VOC containing coatings or solvent per day. The rule also does not apply to coatings that are applied in volumes of less than 20 gal/yr, provided that the total of these coatings does not exceed 200 gal/yr. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined In 2005, 0.28 tpd of VOC are expected to be reduced.

Permanence

Measurable

Availability

COST-EFFECTIVENESS - Estimated to be $4,000 - $5,000/ton of VOC.

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through the recordkeeping and reporting requirements.

Ease of Determining Compliance

Compliance would be determined via review of facility reporting material and/or on-site inspections

Implementation Ease

Most of the VOC limits and operating practices are already in place in SCAQMD, so the rule is not technology-forcing.

Timing of Reductions

Assuming that limits could be put in place by 1998, then 1999 should be the year to apply reductions.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Likely reductions of VOC HAPs with reformulation. Potential reduction of PM10 with increased transfer efficiency. Secondary Benefits - materials, agricultural, tourism, land use, etc. Lower amounts of coatings used on an as-applied solids basis. Secondary Costs

MEASURE NO. 3
SOURCE CATEGORY Autobody Refinishing
CONTROL MEASURE South Coast, CA Emission Limits

DESCRIPTION

This control measure is based on the adoption of VOC limits for autobody refinishing consistent with the 1997 SCAQMD Rule 1151 coating limits (SCAQMD, 1993). This rule specifies VOC limits for coatings that are more stringent than those specified for 1997 in the Auto Refinishing ACT (EPA, 1994a). SCAQMD provides two sets of limits: one for "Group I Vehicles" (large trucks, buses, and mobile equipment) and another for "Group II Vehicles" (passenger cars, small trucks and vans, medium-sized trucks and vans, motor homes, and motorcycles). A comparison of the VOC limits for Rule 1151 with those from the ACT are given below (all limits are VOC minus water and exempt compounds):

Product	ACT Limit (g/l)	1997 Rule 1151 Group I (g/l)	1997 Rule 1151 Group II (g/l)
Primer/Surfacer	550	250	250
Primer Sealer	550	250	340
Topcoat	600	340	420
Topcoat 3-Stage	625	340	420
Specialty	840	840	840

For the purposes of developing emission reduction estimates below, it is assumed that the refinishing of Group II vehicles contribute most of the emissions for this category.

If these limits are added to the existing PA rule on surface coating, it may be necessary to specify lower VOC emission thresholds (i.e., lower than 3 lb/hr or 15 lb/day) in order to capture auto refinishing operations which are all considered area sources in the inventory. All of the limits are on an as-applied basis. For this reason, SCAQMD did not address point-of-sale issues [i.e., purchase of higher VOC coatings from outside of the nonattainment area (NAA) for use within the NAA]. It is recommended that the proposed control measure be structured in the same way for the five county area.

3. Autobody Refinishing: Require the Use of Low-VOC Paints
COST
Capital Cost N/A. Capital costs are assumed to be $0.00, since no new equipment are needed based on the experiences of the SCAQMD (Latif, 1996). Operating and Maintenance Cost O&M costs are assumed not to change significantly. Some formulations will require longer drying times, however SCAQMD did not report significant operational problems with their facilities (Latif, 1996). Costs for the reformulated products will be slightly higher on a volume basis, but will be partially offset since the solids content will be higher (i.e., there will be more coverage per gallon). Some facilities in the South Coast District have reported longer drying times associated with the use of the reformulated products. There has not been a move by the industry to install drying equipment. Rather, most refinishers are dealing with longer drying times by scheduling their jobs to allow for more drying time (Latif, 1996).

Annualized Direct Costs

Not available.

Administrative Costs/Issues

It would be necessary to establish recordkeeping requirements, so that it can be verified that sources within the NAA are using compliant coatings. Therefore, additional costs can be expected for both industry and regulatory agencies for preparation and review of recordkeeping and reporting materials.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

Reductions are estimated based on the difference between Option 1 VOC limits of the National Rule (EPA, 1995) for primers/primer surfacers and topcoats and the 1995 limits in SCAQMD Rule 1151 for Group II vehicles (SCAQMD, 1993). This assumes equivalent coverage of coatings with either set of limits (this is a conservative assumption, since the reformulated products will likely have greater coverage by volume). Based on the difference in VOC limits, a conservative estimate of 35% VOC emission reductions are assumed.

Applicability - how many sources, their size

Not Available. This control measure will affect a large number of area sources.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

In 2005, 3.8 tpd of VOC are expected to be reduced.

Permanence

Emission reductions are assumed to be permanent.

Measurable

Emission reductions could be tracked via periodic review of source recordkeeping documentation.

Availability

No availability issues. SCAQMD does not anticipate that refinishers will have difficulty in meeting the 1997 limits (Latif, 1996). Most of the Group I and Group II limits have been in place since 1995. The only exceptions are: Metallic/Iridescent Topcoats for Group I vehicles drop from 420 g/L in 1995 to 340 g/L in 1997; For Group II vehicles, Metallic/Iridescent Topcoats drop from 520 g/L in 1995 to 420g/L in 1997 and Primer Sealers drop from 420 g/L to 340 g/L (SCAQMD, 1993).

COST-EFFECTIVENESS - Conservatively estimated to be $3900-5,800/ton of VOC. The low end of the range is based on the incremental cost effectiveness calculated by EPA for Option III over Option I coatings for the national rule (EPA, 1995). SCAQMD limits are still lower than EPA Option III limits, so the cost effectiveness could be lower. The high end of the range is the cost effectiveness reported in the original 1991 staff report for Rule 1151 (Latif, 1996). These estimates are based on the increased costs for the 1995 VOC limits (products that are currently in use), therefore it is not known how representative they are for the 1997 limits. It is assumed that since the products are already under development for use in the South Coast District, costs associated with product development will likely be lower and that the cost effectiveness will not be greater than the range reported above.

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through periodic inspection of source recordkeeping requirements.

Ease of Determining Compliance

Compliance would be determined via review of facility recordkeeping material and on-site inspections.

Implementation Ease

The VOC limits of the rule should not be technology-forcing, since SCAQMD refinishers have been using 1995-compliant coatings for over a year. The 1995 limits for Group II Vehicles are nearly the same as those for 1997, with the major exception being primer sealers which drop from 420 g/L in 1995 to 340 g/L in 1997.

Timing of Reductions

Assuming that limits could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Due to the reasonable cost, the availability of low-VOC substitutes, and the fact that SCAQMD refinishers have been using these coatings for over a year, there should not be considerable issues related to political acceptability.

Consensual

Voluntary   Who Pays - Fairness The control measure is designed to cover all sources in the source category, so the costs are spread evenly among all sources.   Location ?
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Likely reductions of VOC HAPs with the use of low-VOC coatings.   Secondary Benefits - materials, agricultural, tourism, land use, etc. Since the reformulated products will likely have higher solids content, fewer materials (VOC solvent) will be consumed.   Secondary Costs None identified.

MEASURE NO. 4
SOURCE CATEGORY Degreasing
CONTROL MEASURE Adopt South Coast California Rule

DESCRIPTION

This control measure is based on the proposed amended SCAQMD Rule 1171 (SCAQMD, 1995). The rule requires the use of aqueous solvents for anyone using VOC-containing solvents during the production, repair, maintenance, or servicing of parts, products, tools, machinery, equipment, or general work areas, and to all persons who store and dispose of VOC-containing materials used in solvent cleaning. There are requirements for cleaning devices and methods, as well as storage/disposal and recordkeeping requirements. Notable exemptions are:

1. Cleaning that is carried out in batch-loaded cold cleaners, open-top vapor degreasers, conveyorized degreasers, or film cleaning machines which are regulated under SCAQMD Rule 1122 - Solvent Degreasers;
2. Dry Cleaners (already subject to SCAQMD Rules 1102 and 1421);
3. Semi-conductor manufacturing solvent cleaning operations subject to Rule 1164);
4. Aerospace Assembly and Component Manufacturing Operations subject to Rule 1124;
5. Coatings and Ink Manufacturing subject to Rule 1141.1;
6. Janitorial and Institutional Cleaning;
7. Stripping of cured coatings, cured adhesives, or cured inks;
8. Cleaning operations using solvents with a water content of 98% or more, by weight.

Notable exemptions from the VOC content limits specified in the rule are:

1. Cleaning of solar cells, laser hardware, scientific instruments, and high-precision optics;
2. Cleaning associated with R&D, performance tests, and quality assurance tests.
3. Use of less than 1.5 gallons/day for medical/pharmaceutical applications.

The rule also prohibits the use of CFC's and 1,1,1-TCA for solvent cleaning after January 1, 1997.

4. Solvent Cleaning and Degreasing: Require the Use of Low-VOC Solvents
COST
Capital Cost Not Available. For many of the small users (e.g., auto repair shops) there will be no capital costs, since the equipment is often leased. For larger operations (e.g., industrial), new solvent cleaning tanks equipped with heaters and/or oil skimmers may be needed for the aqueous solvent systems (Liebel, 1996). Operating and Maintenance Cost Not Available. According to SCAQMD, costs are expected to be lower with aqueous systems, since the solvent baths do not have to be serviced as often (Liebel, 1996). Annualized Direct Costs Not Available.

Administrative Costs/Issues Recordkeeping requirements - Sources are required to keep records of solvent usage unless they are exempted by either of the following: 1) they are not subject to any other recordkeeping requirements of any other rules (e.g., coating rules); 2) solvent cleaning is performed with a solvent which has a water content of at least 98% by weight, or a VOC composite partial pressure of 0.1 mmHg or less at 20 degrees C, or the solvent contains VOC that consists of 12 or more carbon atoms.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels SCAQMD estimated a 40% reduction in VOC (SCAQMD, 1994). This could be a conservative (low) reduction estimate for the Philadelphia NAA, since SCAQMD already had a previous version of the rule in place (which had operational, storage/disposal and recordkeeping requirements). Applicability - how many sources, their size N/A. This control measure will affect a large number of both point and area sources. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined In 2005, 5.9 tpd of VOC are expected to be reduced. Permanence Emission reductions are assumed to be permanent. Measurable Emission reductions could be tracked via a review of source recordkeeping documentation. Availability No availability issues.
COST-EFFECTIVENESS - Estimated to be $Cost Savings - $100/ton of VOC (SCAQMD, 1994).
IMPLEMENTABILITY
Enforcement Enforcement would be implemented through the recordkeeping requirements. Ease of Determining Compliance Compliance would be determined via review of facility recordkeeping material and on-site inspections.

Implementation Ease

The VOC limits of the rule may be technology-forcing for some operations. Some operations may require the use of different operating procedures (e.g., longer cleaning operations) or different equipment (e.g., cold cleaners designed for aqueous solvents).

Timing of Reductions

Assuming that limits could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Due to the low cost and relative availability of low-VOC substitutes, the should not be considerable issues related to political acceptability.

Consensual

Voluntary

Who Pays - Fairness

The control measure is designed to cover the bulk of the source category, so the costs are spread among both large and small sources.

Location

?

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Likely reductions of VOC HAPs with the use of low-VOC solvents.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Since the volatility of aqueous solvents is significantly lower than the VOC counterpart, lower quantities of solvents may be needed on a per part cleaned basis.

Secondary Costs

None identified.

MEASURE NO. 5
SOURCE CATEGORY Gasoline Service Stations: Underground Storage Tanks
CONTROL MEASURE Install Pressure-Vacuum Valves on Vent Line

DESCRIPTION

The use of Pressure-Vacuum (PV) valves on UST vent pipes can reduce VOC emissions from tank breathing losses by 99%. This control measure would require that PV valves be installed on UST vent pipes at all Gasoline Service Stations and Fleet Operator fueling facilities. These P-V valves significantly reduce breathing losses from USTs and also increase the efficiency of Stage I and Stage II controls (Kununiak, 1996).

Some people have raised safety concerns regarding the use of P-V valves. Primarily, this relates to possible overpressure situations, if the valve were to fail and close. The CA State Fire Marshall reviewed this issue in 1990 and determined that there was no cause for safety concerns. In addition, the BAAQMD has had a requirement for P-V valves on all gasoline USTs since 1990 and for some USTs since the 1970's. No safety issues have resulted from this experience (Kununiak, 1996).

5. Gasoline Service Stations: Require the Use Pressure-Vacuum Valves on UST Vent Pipes
COST
Capital Cost According to SMAQMD (1995), capital costs are expected to be between \$80 and \$90 per valve. Owners can install these valves themselves, or pay about \$200 per valve to be installed. The capital costs will vary by facility depending on the number of vent pipes, whether the vent pipes can be manifolded together and served by one P-V valve, and whether or not the owner installs the equipment. Another source quotes lower capital costs of about \$50 to \$80 per valve (Kununiak, 1996). Operating and Maintenance Cost There are no maintenance costs associated with P-V valves. Annualized Direct Costs An upper end of the annualized cost range was calculated using the following assumptions: small facility (75,000 gallons throughput/yr); one P-V valve needed; owner contracts the installation of valve at \$200; and installation of valve is financed at 10% over 10 years. This leads to annual direct costs of \$32.60/yr. Administrative Costs/Issues It would be necessary to verify installation of valves by the affected sources.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

99% for Stage I (an increase from 95% assumed to be used in the inventory); 99% for breathing losses; and a 2.3% increase in the efficiency of Stage II controls (Kununiak, 1996).

Applicability - how many sources, their size

Not Available. This control measure will affect a large number of area sources.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

In 2005, 2.3 tpd of VOC are expected to be reduced (2.0 tpd from breathing losses; 0.1 tpd from Stage II; and 0.2 tpd from Stage I).

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via the performance tests required by the rule.

Availability

No availability issues. None of the air districts in California have experienced a problem with availability.

COST-EFFECTIVENESS - $615/ton is the upper end of the cost effectiveness range calculated using the annualized costs above and the hypothetical emissions from the Stage I&II controlled small facility above. Costs will likely be much lower since most facilities will have more than one vent pipe (that may be manifolded together) and will likely pay less for valves and installation.

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through periodic inspection and source reporting requirements.

Ease of Determining Compliance

Compliance would be determined via review of source reporting requirements/inspections.

Implementation Ease

This measure should be easily implemented. None of the air districts in California that have P-V valve requirements have reported implementation issues.

Timing of Reductions

Assuming that the requirement could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Due to the low cost, previous implementation in other areas, and the availability of equipment, there are no known issues that would make this measure politically unacceptable.

Consensual

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all sources in the source category, so the costs are spread evenly among all sources.

Location

The requirement applies to all sources in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reductions of VOC HAPs (e.g., benzene) will also occur as a result of this measure.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Gasoline that would have been lost to the atmosphere can be used as fuel, which will lower overall gasoline consumption in the NAA.

Secondary Costs

None identified.

MEASURE NO. 7
SOURCE CATEGORY Petroleum Refinery Fugitives
CONTROL MEASURE More Stringent LDAR

DESCRIPTION

This control measure calls for an increase in the stringency of leak detection and repair (LDAR) programs at petroleum refineries. 25 PA Code 129.58 requires refineries to conduct a quarterly LDAR program using a 10,000 ppm VOC leak definition when monitoring components (e.g., pumps, valves). This control measure would be modeled after Rule 1173 of the SCAQMD and CARB's RACT (Pechan, 1994). The major differences in stringency are that: 1) the leak definition (the monitored level at which a component is considered to be leaking and therefore requires repair) is lowered from 10,000 ppm to 1,000 ppm; and 2) connectors are also monitored at 1,000 ppm on an annual basis.

The primary difference between the proposed rule described above and the Refinery MACT standard is that the MACT standard does not require LDAR for connectors (Pechan and Mathtech, 1994). Connectors would require quarterly LDAR until the number of leakers is limited to no more than one connector. When this performance requirement is met, the inspection schedule for connectors reverts to an annual schedule. EPA determined that the incremental costs outweighed the benefits for LDAR of connectors (e.g., pipe fittings). Another minor difference is that the leak definition for pumps is lower than the MACT standard (2,000 ppm). Conservative, incremental reduction and cost estimates between the MACT standard and the proposed rule are based solely on the requirement for inspection of connectors and are described in more detail below.

7. Refineries: Increased Stringency of Leak Detection and Repair Programs
COST
Capital Cost Component population data were not available for refineries in the 5 counties area. Using data from ten refineries in the SCAQMD (Pechan, 1994), capital costs associated with incorporating connectors into the LDAR program were estimated to be $3,667,500. Operating and Maintenance Cost Using the same SCAQMD refinery connector population figures, O&M costs were estimated to be between $158,000 and $597,000/yr. The range of values depends on whether the refineries were practicing quarterly or annual LDAR on connectors (i.e., whether or not they were meeting leak performance targets). Annualized Direct Costs Same as O&M above. Administrative Costs/Issues Annual indirect costs (overhead, administrative, taxes, insurance, and capital recovery costs) were estimated to be between $839,300 and $1,102,700, again depending on whether quarterly or annual LDAR was being performed.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

Reductions are based on estimates of the fraction of fugitive leak emissions contributed by connectors. This lack of a requirement for LDAR on connectors is the primary difference between the Refinery MACT and the proposed rule. Data from the SCAQMD on refineries that already inspect connectors on a quarterly basis (to comply with Rule 1173), indicate that connectors contribute 26% of the total controlled emissions (Pechan, 1994a). Instituting quarterly LDAR on these components is estimated to yield 70% control (Pechan, 1994a). This provides an overall incremental 18% control of the fugitive emissions. This estimate is considered to be conservative (low) because it is derived from data on components that are already being inspected. Therefore, the PA refineries are likely to have higher initial connector fugitive emissions contributions.

Applicability - how many sources, their size

From the 1990 inventory, there appear to be eight refineries in the five county area.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

In 2005, 0.95 tpd of VOC are expected to be reduced (this reflects reductions for refineries in the five county area).

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via the performance source reporting requirements.

Availability

No availability issues.

COST-EFFECTIVENESS - estimated to be $680 - $1,150/ton of VOC estimated from data from SCAQMD refineries (Pechan, 1994a). Total annualized costs were $997,300 - $1,699,700 and total annual emission reductions were 1,471 tons (4.03 tpd). **NOTE: These values are derived from data on 10 SCAQMD refineries.**

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through periodic inspection and source reporting requirements.

Ease of Determining Compliance

Compliance would be determined via review of source reporting requirements/inspections.

Implementation Ease

This measure should be easily implemented, since an existing LDAR program requirement is in place.

Timing of Reductions

Assuming that limits could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Due to the low cost and previous implementation in other areas, there are no known issues that would make this measure politically unacceptable.

Consensual

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all sources in the source category, so the costs are spread evenly among all sources.

Location

?

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reductions of VOC HAPs (e.g., benzene) will also occur as a result of this measure.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Vapors that would have been lost to the atmosphere can become product, lowering raw materials usage or product loss.

Secondary Costs

None identified.

MEASURE NO. 8
SOURCE CATEGORY Rule Effectiveness Improvements
CONTROL MEASURE Increased Compliance Activities

DESCRIPTION

This control measure calls for an improvement in the implementation of regulation. A rule effectiveness improvement may take several forms, ranging from more frequent and in-depth training of inspectors to larger fines for sources that do not comply with a rule.

8. Rule Effectiveness Improvements
COST
Capital Cost Not Available. For some sources, there will be no capital costs (e.g., increased reporting/recordkeeping). For others, capital costs may apply (e.g., increased stack monitoring). Operating and Maintenance Cost Not Available. Refinery component population figures needed to develop O&M costs. Annualized Direct Costs Not available. Administrative Costs/Issues There will be a large increase on the administrative burden of the state to increased rule effectiveness, including training costs, additional inspection costs, and review of increased facility reporting submittals. Facilities will also face additional administrative burdens, including increased reporting/ recordkeeping.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels It is assumed that the rule effectiveness will be increased from 80% to 90% for emission points with base year RACT- or NSPS-level controls. Applicability - how many sources, their size Not Available. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined In 2005, VOC reductions equivalent to an additional 10% of the uncontrolled levels are expected for all affected sources.

Permanence

Emission reductions are assumed to be permanent.

Measurable

Emission reductions could be tracked via the performance source reporting requirements.

Availability

No availability issues.

COST-EFFECTIVENESS - Total annual costs are estimated to be 30% of the annual costs for any particular VOC control (Pechan, 1994b). Cost Effectiveness is unavailable.

IMPLEMENTABILITY

Enforcement

The control measure is based on increased enforcement activities (e.g., more frequent inspections, higher penalties, increased reporting).

Ease of Determining Compliance

Inherent to the rule, compliance would be determined via review of source reporting requirements and inspections.

Implementation Ease

Variable depending on the source and the methods chosen for rule effectiveness improvement.

Timing of Reductions

Assuming that limits could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

Consensual

Voluntary

N/A.

Who Pays - Fairness

Location

?

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reductions of VOC HAPs will likely occur as a result of this measure.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Lower raw materials consumption or product loss may occur for some sources as a result of the rule.

Secondary Costs

None identified.

MEASURE NO. 9
SOURCE CATEGORY Web Offset Lithography
CONTROL MEASURE Beyond Control Technique Guideline Requirements

DESCRIPTION

This control measure calls for application of additional controls beyond RACT for Offset Lithographic Printers. EPA issued a draft CTG for Offset Lithography in 1993. This CTG was never finalized, but was followed up with an ACT document (EPA, 1994). The same controls were specified in the ACT document (e.g., low-VOC fountain solutions and solvents, 90% add-on control of drier exhaust). The controls were to be applied to all sources within the NAA, since EPA did not specify a lower-size threshold in the draft CTG (EPA, 1994).

Discussions with SCAQMD staff revealed that most of the sources have complied with SCAQMD Rule 1130 by using compliant fountain solutions and solvents. Even for those sources with heatset operations, most did not use add-on controls for the drier [driers are only used for heatset operations (Hopps, 1996)]. Additional add-on controls would only affect heatset web lithographers that had not installed controls previously. Also, in regards to the other two sources of VOC emissions, fountain solutions and solvents that are lower in VOC content than those specified in the draft CTG/ACT may not be available. SCAQMD Rule 1130 covering graphic arts, including offset lithography, was recently amended and includes VOC limits that are no more stringent (and possibly less stringent) than the draft CTG limits (SCAQMD, 1993). Rule 1130 limits fountain solution VOC content to 100 g/l, compared to 1.6% - 8.0% by volume (about 68 g/l of iso-propyl alcohol at 8.0%) in the CTG (depending on the process). Clean up solvents in Rule 1130 are limited to 900 g/l compared to 30% by volume in the draft CTG (about 330 g/l if calculated in terms of mineral spirits).

Additional information is needed regarding the types of solvents and fountain solutions used by sources in the NAA. Also, for heatset operations, information is needed as to the sources that are using add-on controls for the drier exhaust. If sources are generally in compliance with the draft CTG-limits, then additional emission reductions may be difficult to obtain with existing product formulations.

Web Offset Lithography: Beyond RACT Controls
COST
Capital Cost Not Available. Operating and Maintenance Cost Not Available. Annualized Direct Costs Not Available. Administrative Costs/Issues

EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels
Applicability - how many sources, their size Not Available. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Permanence Measurable Availability
COST-EFFECTIVENESS -
IMPLEMENTABILITY
Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

N/A.

Who Pays - Fairness

Location

?

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

None identified.

MEASURE NO. 10
SOURCE CATEGORY Graphic Arts
CONTROL MEASURE Extend RACT to Small Sources

DESCRIPTION

This control measure calls for application of RACT-level controls to small graphic arts sources. CTG-level controls are currently embodied in PA Rule 129.67 covering rotogravure and flexographic printing sources. The rule applies to sources with actual or potential emissions greater than 100 tpy or 1,000 lbs/day. Sources can comply by either limiting the VOC content of inks or using capture and control methods for the press emissions. No limits are specified for cleaning solvents.

A review of the 1990 emissions inventory found 13 facilities practicing flexography and six facilities performing gravure that had total surface coating emissions less than 0.5 tpd (and hence potentially not required to comply with the state regulation. The combined flexographic and gravure emissions from these facilities was representing 2.22 tpd in 1990. Some of these facilities may be using compliant formulations regardless of the state regulation or may have potential emissions above the 0.5 tpd limit (requiring compliance). Therefore, the 2.22 tpd figure represents an upper end of the emissions available for control.

An alternative to the above control measure would be to institute more stringent VOC limits for all sources. According to EPA (1995), if these limits were consistent with those used by both SCAQMD and the Bay Area Air Quality Management District (BAAQMD), emission reductions of up to 50% for those facilities complying with RACT through the use of compliant coatings. The comparison made by EPA shows that the California districts' limits of 0.24 lb VOC/lb solid compares with an equivalent RACT limit of 0.50 lb VOC/lb solid. As previously mentioned, these reductions only apply to the portion of the source category that use compliant coatings as RACT (since the source has a choice of using add-on controls versus low-VOC coatings).

10. Graphic Arts: Extend RACT Controls to Smaller Sources
COST
Capital Cost Not Available. It is likely that no capital costs would be involved, only changes to compliant coatings and process changes. Operating and Maintenance Cost Not Available. Annualized Direct Costs Not Available. Administrative Costs/Issues Although not currently required under the state regulation, administrative costs would be incurred by both industry and the state during reporting/recordkeeping to demonstrate compliance, if these requirements were included in the control measure.

EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Based on the requirements for add-on control emission reduction requirements from the draft CTG, a 65% reduction is assumed. Hence, it is also assumed that if compliant coatings are used to comply with the rule, then similar emission reductions will occur. Applicability - how many sources, their size Not Available. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Emissions in 2005 are estimated at 2.37 tpd. Using the 65% emission reduction estimate above, VOC reductions in 2005 would be about 1.54 tpd. Permanence Reductions are assumed to be permanent. Measurable Reductions could be measured via facility reporting/recordkeeping requirements, if these are included as part of the control measure. Availability As mentioned in the introductory section, the availability of emission reductions hinges on whether or not the identified small emitters are currently using formulations that are compliant with RACT. If these facilities are already using compliant coatings (due to their ready availability or cost) then a portion or all of the emission reductions may not be available.
COST-EFFECTIVENESS - $3,500-4,800/ton (based on add-on controls; STAPPA/ALAPCO, 1993). Switching to lower VOC formulations should be much more cost effective.
IMPLEMENTABILITY
Enforcement Enforcement would be performed via review of source reporting or recordkeeping. Ease of Determining Compliance Compliance determinations would also be determined via review of reporting or recordkeeping.

Implementation Ease

Switching to lower VOC inks may require some facilities to change operating practices or install higher capacity driers (STAPPA/ALAPCO, 1993). Other facilities may be able to transition to the lower VOC formulations without having to make significant changes.

Timing of Reductions

If a revision to the existing RACT rule can be adopted by 1998, then 1999 would be the year in which to take credit for reductions.

Publicly Acceptable

No issues anticipated.

Politically Acceptable

No issues anticipated.

Consensual

?

Voluntary

N/A.

Who Pays - Fairness

Location

?

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Some VOC HAPs may be reduced as a result of this measure.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Since, the new formulations will have a lower VOC content (largely replaced by water), there will be fewer raw materials consumed per print job.

Secondary Costs

None identified.

MEASURE NO. 13
SOURCE CATEGORY Utility Boilers
CONTROL MEASURE Selective Catalytic Reduction (SCR)

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST:
Capital Cost Average Coal Fired Utility Boiler is about 2250 mmbtu/hr. According to EPA SCR can be added to these boilers at a cost of: $20,250,000 per boiler Operating and Maintenance Cost Operating and maintenance costs are made up of a fixed component which includes equipment maintenance, personnel expenses and overhead costs. In addition there is a variable cost which includes consumables such as electricity and chemicals. According to EPA the fixed cost for the average utility boiler is: $1,441,000 The variable cost assuming a utilization of 50% is: $1,058,000 the total operating and maintenance cost is $2,502,000 Annualized Direct Costs For a typical 2250 mmbtu/hr input boiler the total annual cost is: $6,600,000/yr Administrative Costs/Issues Recordkeeping - Sources would be required to install CEM systems and chemical usage monitoring systems.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels 80% -- This represents the reduction from current levels. All utility boilers have installed low NOx burners and reductions are taken from the level of installed equipment. Applicability - how many sources, their size There are three coal fired utility boilers. The average size is about 2250 mmbtu/hr. The system would also reduce emissions when these plants fire oil or gas as a secondary fuel.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

NOx emission reductions from 1996 levels would be about 24 tpy in 2005. The reductions are above the emission control measures already in place at PECO plants.

Permanence

Reductions are expected to be permanent.

Measurable

Emission reductions would be measurable either through stack sampling or Continuous emission monitoring

Availability

The control equipment is available

No availability issues.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

The cost effectiveness for any particular unit is a function of unit size and utilization. On average, a cost effectiveness of about $4,000/ton removed can be expected. This is based on annual emissions from the affected plants of about 6,400 tons/year.

IMPLEMENTABILITY

Enforcement

Enforcement would be through recordkeeping requirements. The sources are ones which are routinely inspected.

Ease of Determining Compliance

During the compliance inspection, compliance could be determined easily.

Implementation Ease

The number of sources is small and equipment is available.

Timing of Reductions

Emission reduction could be implemented within four years after the regulations requiring the control technology were implemented.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Emissions of ammonia may increase slightly.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None

Secondary Costs

MEASURE NO. 12
SOURCE CATEGORY Pesticides
CONTROL MEASURE Reformulation and Application Changes

DESCRIPTION

This control measure calls for reformulation of pesticides and changes to application techniques for agricultural and commercial enterprises (household and institutional products are regulated under consumer products rules). The term pesticide includes insecticides, fungicides, and herbicides (SCAQMD, 1994). Both EPA Region IX (for the CA FIPs) and SCAQMD have proposed rules to limit VOC emissions from pesticide application. Region IX's FIP approach was to require manufacturers to register data on their products with EPA. EPA was then to set VOC limits for each product type. All persons within the FIP areas were then prohibited from using or storing pesticides that did not meet the VOC limits (SCAQMD, 1994).

SCAQMD's proposed approach is to use both VOC reformulation and changes in application techniques to reduce VOC emissions. Methods proposed to limit VOC content include: reformulation from hydrocarbon bases to water bases; adding thickening agents to increase particle size and viscosity of the spray which, in turn, reduces spray drift; substituting lower vapor pressure solvents to reduce evaporation; and using synthetic formulations. Methods proposed for changes in application include: dusting rather than spraying, where reformulation is not possible; modifying the spray device, such that fine droplets are not formed during application; lowering the spray nozzle height; and incorporating pesticide into the soil immediately following or in place of spraying (SCAQMD).

SCAQMD's proposed rule was selected over EPA's FIP rule, since SCAQMD's proposed rule allows for much more flexibility in achieving compliance. The California Department of Pesticide Regulation (DPR) is currently developing a statewide regulation to cover pesticide application (Pritchard, 1996). As specified in the CA SIP, DPR must put a control program in place to achieve a 20% reduction in VOC emissions by 2005. The program is expected to obtain emission reductions via both voluntary reformulations from manufacturers and mandatory reformulations and changes in application technique (since voluntary reductions are expected to fall short). The regulation is expected to be in place by 6/97.

12. Pesticides: Lower VOC Constituents/Changes in Application Techniques
COST
Capital Cost Not Available. Operating and Maintenance Cost Not Available. Annualized Direct Costs Not Available.

Administrative Costs/Issues

The State of California already has a sophisticated recordkeeping and regulatory system in place. Therefore, any recordkeeping and reporting burden associated with a VOC regulation would be minimal in California. In PA however, there could be much more of a burden both on the source and the State, if such a system is not already in place. It is assumed that, administrative costs would be incurred by both the sources and the state for reporting/recordkeeping requirements. These are not included in the cost effectiveness value reported below.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

20% (Pritchard, 1996).

Applicability - how many sources, their size

Not Available.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

Emissions in 2005 are estimated at 1.43 tpd. Using the 20% emission reduction estimate above, VOC reductions in 2005 would be about 0.29 tpd.

Permanence

Reductions are assumed to be permanent.

Measurable

Reductions could be measured via facility reporting/recordkeeping requirements, if these are included as part of the control measure.

Availability

All emissions in the inventory are assumed to be available for reduction.

COST-EFFECTIVENESS - $1,000/ton (SCAQMD, 1994). CA DPR has not yet gathered any cost information for it's regulation currently under development (Pritchard, 1996).

IMPLEMENTABILITY

Enforcement

Enforcement would be performed via review of source reporting or recordkeeping.

Ease of Determining Compliance

Compliance determinations would also be determined via review of reporting or recordkeeping.

Implementation Ease

Since no pesticide rules have yet gone into effect, it is not yet clear how difficult the rule would be to implement. The SCAQMD's proposed rule would be much more difficult to implement than the EPA FIP rule due to the number of different ways that sources could consider for compliance. However, this greater flexibility would also be much more palatable to the sources which would increase the ease of implementation to some degree.

Timing of Reductions

If a rule can be adopted by 1998, then 1999 would be the year in which to begin taking credit for reductions. Full reductions should not be assumed until 2005, when CA will have its program fully implemented (Pritchard, 1996).

Publicly Acceptable

No issues anticipated.

Politically Acceptable

No issues anticipated. As stated above, the proposed SCAQMD rule would allow for greater flexibility and likely more approval from the regulated community.

Consensual

Voluntary

According to Pritchard (1996), CA DPR has not been very successful in obtaining voluntary reductions over the last couple of years. Therefore, no voluntary reductions are assumed here.

Who Pays - Fairness

The control measure would cover all agricultural and commercial sources.

Location The measure would cover the 5 county area.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Some VOC HAPs may be reduced as a result of this measure, as well as primarily or secondarily formed PM. Changes in application techniques could lead to lower exposures of off-site receptors to VOC HAPs. By allowing sources to use dusting instead of spraying, emissions of PM could be increased in certain circumstances. Secondary Benefits - materials, agricultural, tourism, land use, etc. Since, the new formulations will have a lower VOC content (replaced by water in some instances) and application techniques will be changed to reduce drift, there will be fewer raw materials consumed per application. Secondary Costs None identified.

MEASURE NO. 13
SOURCE CATEGORY Gas/oil utility/electricity producing boilers
CONTROL MEASURE Selective Catalytic Reduction (SCR)

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST:
Capital Cost The typical boiler size is about 1,000 mmbtu/hr According to EPA the cost for this size boiler is: $8,500,000 per boiler Operating and Maintenance Cost Annual cost is made up of a fixed and variable component. The fixed component covers operation and maintenance of the equipment and the variable portion covers the chemicals and electricity required. The fixed component for the 1000 mmbtu/hr boiler is expected to be: $580,000 The variable component is: $373,333 The total O+M cost is: $963,000 Annualized Direct Costs For a typical 1,000 mmbtu/hr input boiler the annual cost is: $2,370,000 Administrative Costs/Issues Sources would be required to install CEM systems and chemical usage monitoring systems. Recordkeeping - Sources would be required to maintain operation and maintenance records for the SCR equipment.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels 80% - Moderate efficiency is due to the controls already in place at these facilities. Applicability - how many sources, their size About 12 boilers are classified as utility or electricity producing boilers. The typical size of boilers is about 1,000 mmbtu/hr, although some of the industrial boilers are smaller.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Based on 1996 emissions of 38 tons/day in the ozone season, a reduction of 30 tons/day is possible.

Permanence

Reductions are expected to be permanent.

Measurable

Emission reductions are measurable through CEM or stack testing

Availability

No availability issues.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control
Cost effectiveness varies by size and utilization of each boiler. On average a cost effectiveness of $4,400/ton removed can be expected.

IMPLEMENTABILITY

Enforcement

Enforcement would be through recordkeeping requirements. Sources are those which are routinely inspected.

Ease of Determining Compliance

During the compliance inspection, compliance could be determined easily.

Implementation Ease

The potential number of sources and the addition of previously nonregulated sources could pose difficulties in complete implementation.

Timing of Reductions

Emission reduction could be implemented within two years.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Ammonia emissions may increase slightly.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None

Secondary Costs

MEASURE NO. 14
SOURCE CATEGORY Gas/oil boilers >50 mmbtu/hr
CONTROL MEASURE Low Nox Burners (LNB)+ Flue gas recirculation (FGR)

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST:
Capital Cost The range of boiler sizes for this category is very wide (from 50 to 300 mmbtu/hr). A typical size for the boiler is about 75 mmbtu/hr. According to EPA, a LNB+FGR system should cost between \$200,000 and \$450,000 per boiler. The average cost is: \$322,000 Operating and Maintenance Cost Annual cost is made up of both a direct cost associated with the new equipment as well as a 1% fuel cost savings. The fuel savings offsets most of the O+M cost. The expected annual O+M cost is: \$7,000 per year per boiler Annualized Direct Costs For a typical 75 mmbtu/hr input boiler the annual cost is: \$ 70,000/yr Administrative Costs/Issues Recordkeeping - Sources would be required to monitor FGR parameters, including O2 levels. Larger sources have probably installed this equipment, but smaller sources have not.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels 65% -- This should represent an average control efficiency. Some sources may do better and others would not do as well. Applicability - how many sources, their size A large (about 125) number of sources would be affected. Emissions are concentrated in a few (~25) sources where the energy is used for process use as well as space heating. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Based on 1996 emissions the reduction in ozone season emissions should be about 16.5 tons/day. Permanence Reductions are expected to be permanent.

Measurable

Emission reductions would be determined through the monitoring of other performance measures such as O2 levels. Measurements would be secondary.

Availability

No availability issues.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

Cost effectiveness varies by size and utilization. Cost effectiveness is expected to fall into a range of $2,000-4,000/ton.

IMPLEMENTABILITY

Enforcement

Enforcement would be through recordkeeping requirements. Most of the sources in this category are already regulated and inspected.

Ease of Determining Compliance

During the compliance inspection, compliance could be determined easily.

Implementation Ease

There appear to be no issues

Timing of Reductions

Emission reduction could be implemented within two years after the effective date of regulations.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

None

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None

Secondary Costs

MEASURE NO. 14
SOURCE CATEGORY Industrial Boilers - Bituminous Coal fired (all sizes)
CONTROL MEASURE Low NO_x Burners (LNB)

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST:
Capital Cost The typical coal fired boiler is about 150 mmbtu/hr and is fired with pulverized coal. According to EPA a LNB for this size boiler will cost about: $ 700,000 Operating and Maintenance Cost Typical O+M cost for this size boiler is about $140,000/yr Annualized Direct Costs For a typical 150 mmbtu/hr input boiler the annual cost is: $ 250,000 per boiler Administrative Costs/Issues Recordkeeping - For LNB only, no additional recordkeeping would seem to be required.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels 60% -- This should represent an average control efficiency. Some sources may do better and others would not do as well. Applicability - how many sources, their size There are four industrial boilers identified as burning pulverized coal. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Based on an ozone season emission rate of 3.03 tons per day, the emission reduction would be 1.8 tons/day. Permanence Reductions are expected to be permanent.

Measurable Emission reductions could be determined through stack test or CEM. Availability No availability issues.
COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control For a typical 150 mmbtu/hr boiler with a utilization of 60 percent the cost effectiveness of LNB would be about $2,400 per ton removed.
IMPLEMENTABILITY
Enforcement Enforcement would be through recordkeeping requirements. Coal fired boilers are typically regulated. Ease of Determining Compliance During the compliance inspection, compliance could be determined easily. Implementation Ease Timing of Reductions Emission reduction could be implemented within two years after the regulations are effective. Publicly Acceptable Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

CO and VOC emissions may increase slightly.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None

Secondary Costs

MEASURE NO. 18
SOURCE CATEGORY Glass Manufacturing
CONTROL MEASURE NO_x Controls Beyond RACT

DESCRIPTION

This control measure would require NO_x controls beyond RACT for glass manufacturing facilities. EPA issued an ACT document for this source category in 1994 (EPA, 1994c). In this ACT, EPA listed the following control techniques and control efficiencies for glass furnaces: electric boost (10%), cullet preheat (25%), LNB (40%), SNCR (40%), SCR (75%), and oxy-firing (85%). Emission reductions of about 20% were assumed to occur by 1996 through the application of RACT. This control measure calls for additional controls that will achieve emission reductions equivalent to SCR (i.e., either SCR or oxy-firing). SCR or oxy-firing (use of oxygen instead of air for fuel combustion in the furnace) is assumed to achieve at least 75% incremental control of NO_x from glass furnaces.

18. Glass Manufacturing: Beyond RACT NO_x Controls

COST

Capital Cost

EPA (1994c) estimated the following model plant capital costs for SCR and Oxy-firing:

Plant	SCR ($\$10^3$)	Oxy-firing ($\$10^3$)
Pressed/Blown Glass (50 ton glass/day)	528	1,930
Container Glass (250 ton glass/day)	1,390	5,070
Flat Glass (750 ton glass/day)	2,690	9,810

Operating and Maintenance Cost

Not available.

Annualized Direct Costs

EPA (1994c) estimated the following model plant annual costs for SCR and Oxy-firing:

Plant	SCR ($\$10^3$)	Oxy-firing ($\$10^3$)
Pressed/Blown Glass (50 ton glass/day)	404	706
Container Glass (250 ton glass/day)	769	1,860
Flat Glass (750 ton glass/day)	1,200	3,590

Administrative Costs/Issues

No administrative costs were available.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

A 75% incremental efficiency is assumed for either SCR or oxy-firing. Oxy-firing may produce even higher emission reductions.

Applicability - how many sources, their size

From the emissions inventory, there are four companies listed within the Glass Manufacturing SCCs in seven records for glass furnaces. It is assumed that these represent four different facilities with a total of 7 furnaces.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

In 2005, 1.2 tpd of NO_x are expected to be reduced.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via the performance tests or CEM data, if required by the rule.

Availability

No availability issues.

COST-EFFECTIVENESS - EPA (1994c) estimated that the cost effectiveness for SCR on an uncontrolled furnace would range from $800/ton to $2,960/ton. The cost effectiveness for oxy-firing on an uncontrolled furnace was estimated at $2,150 - $5,300/ton. It is assumed that the cost effectiveness range for SCR would not change significantly relative to the estimates for uncontrolled sources. The control efficiency of 75% is still rather conservative for SCR. Also, the effects of the lower mass of emissions available for reduction from the RACT-controlled sources (i.e., lower emission reductions relative to uncontrolled sources leading to an increase in cost effectiveness) would be offset to a certain degree. This would occur due to the lower amounts of reagent needed for RACT-controlled sources relative to uncontrolled sources, which would lower operating costs.

Based on the data presented by EPA (1994c), the cost effectiveness for oxy-firing is assumed to be up to 40% higher than an installation on an uncontrolled source (this is equivalent to the 40% mass of emissions that are unavailable for reduction due to RACT controls).

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through periodic inspection and source reporting requirements. CEM would be an option for the proposed control measure that has not been included in the cost estimates.

Ease of Determining Compliance

Compliance would be determined via review of source reporting requirements/inspections.

Implementation Ease

No issues regarding implementation were identified.

Timing of Reductions

Assuming that the requirement could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

No issues were identified.

Consensual

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all sources in the source category, so the costs are spread evenly among all sources. No lower size cut-offs have been specified.

Location

The requirement applies to all sources in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

Use of SCR will create ammonia slip emissions. Ammonia can combine with sulfate and nitrate to form secondary particulates (i.e., $PM_{2.5}$). Costs and secondary emissions are also associated with the production of the reagent (e.g., ammonia or urea) and the production of electrical energy needed by the control equipment.

MEASURE NO. 20
SOURCE CATEGORY Stationary Gas Turbines: Fuel Oil
CONTROL MEASURE Water Injection, SCR Plus Water Injection

DESCRIPTION

Stationary gas turbines are used for a broad scope of applications, but are most often used to generate electric power. They are available with power outputs ranging from 1 megawatt (MW) to over 200 MW.

For stationary gas turbines, NO_x reduction methodologies have been developed that utilize both combustion control and post-combustion selective catalytic reduction (SCR) techniques. Combustion control methods utilize both wet (water, steam, or water-in-oil emulsion) or dry (lean premixed and rich/quench/lean) techniques to decrease the flame temperature and therefore reduce the formation of NO_x. The post-combustion SCR technique uses an ammonia (NH_3) injection system and a catalytic reactor to chemically reduce NO_x to nitrogen gas (N_2) and water (H_2O).

Oil-fired gas turbines may choose between a water injection system or an SCR + water injection system. Reductions from these controls vary from approximately 70 percent for the water injection system to 94 percent with the additional SCR control.

Areas with NO_x emission limits for gas turbines typically exempt those used for peaking use at power facilities based on hours of utilization per year.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)		
COST - All cost estimates assume 8,000 hours of operation per year.		
Capital Cost		
Output Power (MW)	Water Injection (millions)	SCR + Water Injection (millions)
3.3	396	622
26.3	1,320	1,770
83.3	2,470	4,600
Direct Operating and Maintenance Cost (Annual)		
Output Power (MW)	Water Injection ($ thousands)	SCR + Water Injection (thousands)
3.3	68.9	127.9
26.3	514.5	378.3
83.3	1,147.3	1,009.0
Total Annual Costs		
Output Power (MW)	Water Injection (thousands)	SCR + Water Injection (thousands)
3.3	143	244
26.3	754	654
83.3	1,580	1,650

Administrative Costs/Issues

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

A control efficiency of 70 percent for the water injection system and 94 percent for the SCR + water injection system can be achieved for NO_x.

Applicability - how many sources, their size

There are 22 turbines in the five county area. Most are at PECO Energy facilities (20 units). Turbines used for cogeneration applications are at Sun Refining and Merck Sharp & Dohne (one unit each). The turbines in utility service have emissions that range from 0.01 to 0.5 tpd of NO_x. Cogeneration applications are 2.4 and 0.7 tpd.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

NO_x only. Water injection controls could reduce NO_x up to 4.6 tpd. SCR plus water injection could achieve emission reductions of as much as 6.2 tpd.

Permanence

Yes.

Measurable

Yes.

Availability

Yes.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

Output Power (MW)	Water Injection System ($/ton of NO_x)	SCR + Water ($/ton of NO_x)
3.3	1,720	8,340
26.3	1,000	2,690
83.3	672	2,430

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Could be achieved within 2 years of a new regulation.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

No.

Who Pays - Fairness Utility and industrial facilities. Location Regulation could be written to apply to the five county area.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.   Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs

MEASURE NO. 22
SOURCE CATEGORY Stationary Reciprocating IC Engines: Natural Gas
CONTROL MEASURE SCR or NSCR

DESCRIPTION

Most stationary internal combustion engines are used to generate electric power, to pump gas or other fluids, or to compress air for pneumatic machinery. Reciprocating engines are separated into 3 design classes: 2-cycle (lean burn), 4-stroke lean burn, and 4-stroke rich burn. Each of these have design differences that affect both baseline emissions as well as the potential for emissions control.

Major NO_x sources in Pennsylvania are currently subject to control through a case-by-case RACT determination. In the five county area, major means more than 25 tons per year of NO_x emissions. Because RACT is applied case-by-case, it is not known whether any technologies have been added to the IC engines in the five county area to reduce NO_x since 1990. The most likely situation is that these units are still emitting at 1990 rates.

Modest levels of NO_x control (10-40 percent) can be achieved without adding equipment to these engines. These techniques involve air/fuel adjustment, ignition timing retard, or a combination of these two.

For IC engines, both combustion controls and post-combustion catalytic reduction have been developed. For the highest levels of control, controlled rich burn engines have mostly been equipped with non-SCR (NSCR) that uses unreacted TOCs and CO to reduce NO_x by 80 to 90 percent. NSCR is essentially the same catalytic reduction technique used in autos. Some rich burn engines can be prestratified charge engines that reduce the peak flame temperature in the NO_x forming regions. Lean burn engines have mostly met NO_x reduction requirements with lean combustion controls using torch ignition or chamber redesign to enhance flame stability. NO_x reductions of 70 to 80 percent are typical for numerous engines with retrofit or new unit controls. Lean-burn engines may also be controlled with SCR, but the operational problems associated with engine control under low NO_x operation have been a deterrent.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)

COST

Capital Cost: For NSCR applied to rich-burn SI engines, capital costs vary by size (horsepower) as shown:

Engine Size (hp)	($1,000)
80-500	15-27
501-1,000	27-41
1,001-2,500	41-87
2,501-4,000	87-132
4,001-8,000	132-253

Operating and Maintenance Cost

Annualized Direct Costs for NSCR applied to rich-burn engines by size:

Engine Size (hp)	($1,000)
80-500	69-79
501-1,000	79-90
1,001-2,500	90-124
2,501-4,000	124-158
4,001-8,000	158-244

Administrative Costs/Issues

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

80 to 90 percent NO_x control can be achieved.

Applicability - how many sources, their size

There are 24 units in the five county area with per engine emissions ranging from 0.1 to 0.9 tpd of NO_x. Companies that would be affected by any IC engine regulations include Transcontinental Gas Pipeline, Columbia Gas Transmission, Philadelphia Gas Works, and Eastern Shore Natural Gas Company.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

The CAA 2005 baseline emission estimate for this source category is 11.3 tpd of NO_x, and 0.5 tpd of VOC. An 80 percent reduction would reduce NO_x by 9 tpd.

Permanence

Yes.

Measurable

Yes.

Availability

Yes.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control. Using NSCR applied to rich burn engines, cost per ton is shown for engine size ranges.

Engine Size (hp)	\$/ton of NO_x
80-500	1,260-6,900
501-1,000	750-1,260
1,001-2,500	395-750
2,501-4,000	315-395
4,001-8,000	240-315

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary No. Who Pays - Fairness Pipeline compressor stations. Location Five county area sources.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.   Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs CO emissions may increase with some control techniques.

MEASURE NO. 23
SOURCE CATEGORY Gas/oil refinery process heaters
CONTROL MEASURE Low NO_x Burner plus Flue Gas Recirculation.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)

COST:

Capital Cost

The average size process heater in the refinery industry is about 40 mmbtu/hr. At that size a mechanical draft heater is assumed. For a 40 mmbtu/hr heater the estimated capital cost is:

$ 234,000

Operating and Maintenance Cost

Operating and maintenance costs for a 40 mmbtu/hr heater are:

$9,270

Annualized Direct Costs

For a typical 40 mmbtu/hr input heater the annual cost is:

$ 40,000/yr per boiler

Administrative Costs/Issues

Recordkeeping - Sources would be required to monitor O2 levels and record fuel use. Larger installations would probably be doing this as a matter of routine, but it would be an additional cost for smaller heaters

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

65% -- This should represent an average control efficiency. Some sources may do better and others would not do as well.

Applicability - how many sources, their size

There are approximately 80 process heaters in the inventory. The average size heater is about 40 mmbtu/hr

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Estimated emissions from this source category are 10.4 tons per day. Emission reductions of 6.76 tons per day are possible.

Permanence

Reductions are expected to be permanent.

Measurable

Emission reductions would be determined through the monitoring of other performance measures such as O2 levels. Measurements would be secondary.

Availability

No availability issues.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

Cost effectiveness varies by size and capacity factor. Cost effectiveness is expected to fall within a range of 1500-2300/ton.

IMPLEMENTABILITY

Enforcement

Enforcement would be through recordkeeping requirements. Sources such as these are routinely inspected under current regulations.

Ease of Determining Compliance

During the compliance inspection, compliance could be determined easily.

Implementation Ease

The potential number of sources and the addition of previously non regulated sources could pose difficulties in complete implementation.

Timing of Reductions

Emission reductions could be implemented within two years.

Publicly Acceptable

Politically Acceptable   Consensual   Voluntary   Who Pays - Fairness   Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None

Secondary Costs

MEASURE NO. 24
SOURCE CATEGORY Iron and Steel Mills
CONTROL MEASURE NO_x Controls Beyond RACT

DESCRIPTION

After further review of the point source database file for the Philadelphia NAA, there does not appear to be any iron and steel furnaces that would be covered by the EPA's 1994 ACT Document. Therefore, it is assumed that no emission reduction benefits could be gained via implementation of the following rule. It is recommended that the rule be dropped from further consideration, unless a source(s) is identified that would be covered by the ACT.

This control measure would require NO_x controls beyond RACT for reheating, annealing, and galvanizing furnaces at iron and steel mills. EPA issued an ACT document for this source category in 1994 (EPA, 1994). In the ACT, EPA listed combustion controls [low excess air, LNB, LNB + (flue gas recirculation)] as being applicable to all three furnace types. For annealing furnaces, EPA also considers add-on controls (SNCR and SCR) as being applicable. For the purposes of this analysis, it has been assumed that LNB has been the chosen RACT level of control for all iron and steel furnaces. This control measure calls for additional controls that will achieve emission reductions equivalent to LNB + SCR on annealing furnaces, and LNB + FGR on reheating and galvanizing furnaces.

24. Iron and Steel Mills: Beyond RACT NO_x Controls

COST

Capital Cost

EPA (1994) estimated the following model plant capital costs for SCR applied to annealing furnaces and FGR applied to reheating and galvanizing furnaces:

Furnace Type	SCR ($$10^3$)	FGR ($$10^3$)
Annealing	528	-
Galvanizing	-	5,070
Reheating	-	9,810

Operating and Maintenance Cost

Not available.

Annualized Direct Costs

EPA (1994) estimated the following model plant capital costs for SCR applied to annealing furnaces and FGR applied to reheating and galvanizing furnaces:

Furnace Type	SCR ($$10^3$)	FGR ($$10^3$)
Annealing	528	-
Galvanizing	-	5,070
Reheating	-	9,810

Administrative Costs/Issues

No administrative costs were available.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

A 75% incremental efficiency is assumed for either SCR or oxy-firing. Oxy-firing may produce even higher emission reductions.

Applicability - how many sources, their size

From the emissions inventory, there are

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

In 2005, 1.2 tpd of NO_x are expected to be reduced.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via the performance tests or CEM data, if required by the rule.

Availability

No availability issues.

COST-EFFECTIVENESS - EPA (1994c) estimated that the cost effectiveness for SCR on an uncontrolled furnace would range from $800/ton to $2,960/ton. The cost effectiveness for oxy-firing on an uncontrolled furnace was estimated at $2,150 - $5,300/ton. It is assumed that the cost effectiveness range for SCR would not change significantly relative to the estimates for uncontrolled sources. The control efficiency of 75% is still rather conservative for SCR. Also, the effects of the lower mass of emissions available for reduction from the RACT-controlled sources (i.e., lower emission reductions relative to uncontrolled sources leading to an increase in cost effectiveness) would be offset to a certain degree. This would occur due to the lower amounts of reagent needed for RACT-controlled sources relative to uncontrolled sources, which would lower operating costs.

The cost effectiveness for oxy-firing is assumed to increase modestly (up to 20%, equivalent to the mass of emissions that are unavailable for reduction).

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through periodic inspection and source reporting requirements. CEM would be an option for the proposed control measure that has not been included in the cost estimates.

Ease of Determining Compliance

Compliance would be determined via review of source reporting requirements/inspections.

Implementation Ease

No issues regarding implementation were identified.

Timing of Reductions

Assuming that the requirement could be put in place by 1998, then 1999 would be the year to apply reductions.

Publicly Acceptable

No issues are anticipated.

Politically Acceptable

No issues were identified.

Consensual

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all sources in the source category, so the costs are spread evenly among all sources. No lower size cut-offs have been specified

Location The requirement applies to all sources in the five county region.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.   Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs Use of SCR will create ammonia slip emissions. Ammonia can combine with sulfate and nitrate to form secondary particulates (i.e., $PM_{2.5}$).

MEASURE NO. 26
SOURCE CATEGORY Residential Water Heaters
CONTROL MEASURE Low NO_x Burners

DESCRIPTION

This control measure would require that new residential water heater installations meet NO_x emission standards. Also owners of residential water heaters are required to replace their water heater at the end of its useful life with a heater meeting the same NO_x standards. This control measure is based on SCAQMD's 1994 proposed measure (SCAQMD, 1994). The State would initiate a water heater certification program for all manufacturer's selling water heaters in the NAA.

Further discussion with SCAQMD has revealed that the district is unlikely to issue any new standards for residential water heaters (Lee, 1996). While residential water heaters have been demonstrated to meet an emission limit of 10 ng/J, these units are not thought to be cost effective at present. SCAQMD will revisit this issue in 1999 during the preparation of the 2000 Air Quality Management Plan. It is recommended that emission limits consistent with SCAQMDs current limits of 40 ng/J be adopted instead, since these units have been in production for many years.

COST

Capital Cost

Not available.

Operating and Maintenance Cost

Not available.

Annualized Direct Costs

Not available.

Administrative Costs/Issues

No administrative costs were available.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

In 2005, the control efficiency for the proposed measure (assuming implementation of the measure by 1999) would be 13%. This is based on the assumption of a 12.5 year life for water heaters, 50% replacement between 1999 and 2005, an uncontrolled average emission rate of 54.3 ng/J in 1999 (Pechan, 1993), and the proposed emission limit for new units of 40.0 ng/J in 2005 for the new/retrofitted units.

Applicability - how many sources, their size

This control measure would apply to all gas-fired residential water heaters in the five county region.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

It is assumed that the emission inventory's residential combustion category is made up primarily of natural gas. Using this assumption, for both control measures involving residential combustion (measures #26 and #27), 0.12 tpd of NO_x is expected to be reduced in 2005.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via sales of certified equipment.

Availability

No availability issues, units meeting the 40 ng/J limit have been sold in the SCAQMD for many years.

COST-EFFECTIVENESS - Not available.

IMPLEMENTABILITY

Enforcement

Enforcement would be achieved through periodic inspections of distributors, retailers, and installers of water heaters located within the five county area.

Ease of Determining Compliance

Compliance would be determined via manufacturer's certification program. The manufacturer would be required to display the model number and certification status on the shipping carton and on the rating plate of the water heater.

Implementation Ease

Since the equipment is commercially-available, the main issue would be to allow adequate lead time for equipment vendors/installers to deplete/return their stock of non-compliant heaters.

The rule could also be implemented through a market-based approach (SCAQMD, 1994). Under this approach, new equipment meeting the emission standards would be eligible for emission credits.

Timing of Reductions

Assuming that the requirement could be put in place by 1998, then 1999 would be the year to begin applying reductions. The entire 13% reduction would not occur in 1999, however. The emission reductions would be dependent on the fraction of water heaters that were retrofitted during each year. It could be assumed that emissions would be reduced approximately 2% per year from 1999 to 2005.

Publicly Acceptable

There may be some unhappiness on the part of the public for having to pay a higher price for their water heater under the command and control implementation approach. Under a market-based approach, where any cost difference could be offset by rebates from the purchase of emission credits, there may be more public support.

Politically Acceptable

No issues were identified other than those described above.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all residential gas-fired water heaters in the source category, so the costs are spread evenly among all sources.

Location

The requirement applies to all gas-fired sources in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Since part of the low-NO_x design is often to incorporate better fuel economy (e.g., through better insulation), fewer of the other products of combustion (i.e., besides NO_x, such as CO, VOC, and some HAPs) would be emitted.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

To the extent that the new equipment is designed to be more energy efficient, less fuel will be consumed.

Secondary Costs

None identified.

MEASURE NO. 27
SOURCE CATEGORY Residential Space Heaters
CONTROL MEASURE Low NO_x Burners

DESCRIPTION

This control measure is analogous to control measure #26. However, many air pollution agencies have yet to require the same controls on space heaters as on water heaters. Presumably, this is due to the temporal pattern of emissions from this source category (i.e., Fall and Winter season) versus water heaters (all year around). Since ozone season is during the summer, ozone reduction benefits associated with controlling space heater emissions would be minimal at best. Therefore, it is recommended that this control measure be dropped from consideration. If this control measure is not dropped from consideration, similar costs and emission reductions are assumed for this control measure as for measure #26. No information was identified specifically for space heaters other than information contained in SCAQMD Rule 1111 (SCAQMD, 1993).

27. Residential Space Heaters: Require the Installation of Low NO_x Heaters for All New/Retrofit Applications

COST
Capital Cost Not available.
Operating and Maintenance Cost Not available.
Annualized Direct Costs Not available.
Administrative Costs/Issues No administrative costs were available. Although, if a control measure were established, then an additional administrative burden would be placed on the air pollution control agencies in order to review and process compliance forms.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Assumed to be the same as control measure #26.
Applicability - how many sources, their size This control measure would apply to all gas-fired residential space heater owners and new equipment installers in the five county region.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

In 2005, if this control measure were established, an unknown but very small amount of NO_x would be reduced during the summer ozone season. Estimates of emission reductions for the overall residential combustion category are given under Control Measure #26.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via sales data for new equipment.

Availability

No availability issues.

COST-EFFECTIVENESS - Not available. The cost effectiveness is expected to be very low, since equipment meeting these limits has been available since the mid-1980's.

IMPLEMENTABILITY

Enforcement

As with Control Measure #26, enforcement would be implemented through periodic inspection of distributors, retailers, or installers.

Ease of Determining Compliance

Manufacturer's would be required to include the model number and certification status on both the shipping carton and equipment rating plate.

Implementation Ease

Since the equipment is commercially-available, the main issue would be to allow adequate lead time for equipment vendors/installers to deplete/return their stock of non-compliant heaters.

The rule could also be implemented through a market-based approach (SCAQMD, 1994). Under this approach, new equipment meeting the emission standards would be eligible for emission credits.

Timing of Reductions

If the requirement were to be put in place by 1998, then 1999 would be the year to apply reductions. However, these would be annual reductions. The summer daily reductions would be essentially zero (since space heaters are not used during the summer).

Publicly Acceptable

There may be some unhappiness on the part of the public for having to pay a higher price for their space heater. A market-based approach of establishing emission reduction credits would allow for offsetting the higher costs, if any.

Politically Acceptable

No issues were identified.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all gas-fired space heaters in the source category, so the costs are spread evenly among all sources.

Location

The requirement applies to all gas-fired space heaters in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Since part of the low-NO_x design may be to incorporate better fuel economy, fewer of the other products of combustion (i.e., besides NO_x, such as CO, VOC, and some HAPs) would be emitted. However, as stated above, these reductions would occur during non-Summer months.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None identified.

Secondary Costs

None identified.

MEASURE NO. 28
SOURCE CATEGORY Medical Waste Incinerators
CONTROL MEASURE Selective Non-Catalytic Reduction

DESCRIPTION

This control measure requires the use of add-on controls for all medical waste incinerators (MWIs) to control NO_x. The measure would require that the add-on control achieve a control efficiency equivalent to SNCR which is estimated to be 45% (Pechan, 1994b). The control efficiency and costs are estimated from SNCR applications on municipal waste combustors [MWCs (see Control Measure #29)].

28. Medical Waste Incinerators: Require Application of Add-On Controls Equivalent to SNCR
COST
Capital Cost Not available. Operating and Maintenance Cost Not available. Annualized Direct Costs Not available. Administrative Costs/Issues Administrative costs will be incurred by both the air pollution agency and source if reporting and recordkeeping requirements are included in the rule. Reporting and recordkeeping requirements are recommended to assure compliance with the rule.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Assumed to be the same as MWCs (see control measure #26), which have demonstrated 45% control efficiency using SNCR (Pechan, 1994b). Applicability - how many sources, their size This control measure would apply to all new and existing MWIs in the five county region. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined In 2005, 0.007 tpd of NO_x would be reduced.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via source reporting and recordkeeping requirements. The control measure could also require the use of continuous emissions monitoring (CEM) equipment and subsequent submittal of CEM data with the compliance reports. Costs for CEM requirements have not been included in the cost data presented here.

Availability

No availability issues.

COST-EFFECTIVENESS - Estimated to be $12,000/ton (Pechan, 1994). Estimated to be three to four times the cost of SNCR applications on MWCs, which are much larger units (the average size for an MWC is 600 Mg/day versus 3 Mg/day for an MWI).

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through reporting requirements and/or periodic inspections (especially if CEM are not required).

Ease of Determining Compliance

Compliance would be determined via review of source compliance reports.

Implementation Ease

No issues were identified.

Timing of Reductions

If the control measure was adopted by 1998, then 1999 would be the year to apply reductions, assuming the source is allowed one year to achieve compliance.

Publicly Acceptable

No issues were identified.

Politically Acceptable

No issues were identified.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all MWIs, so the costs are spread evenly among all sources.

Location

The requirement applies to all MWIs in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Ammonia slip emissions from the SNCR control will increase $PM_{2.5}$ emissions from the source, since the ammonia will combine with sulfate and nitrate either in the stack or ambient air to form a particulate ammonium salt. The control will also require a small amount of electricity to drive compressors and other electrical equipment which can be associated with emissions of various criteria pollutants, GHGs, and HAPs from the power generation source.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None identified.

Secondary Costs

Consumption of reducing reagent (e.g., ammonia or urea) and the energy associated with producing these chemicals.

MEASURE NO. 29
SOURCE CATEGORY Municipal Waste Incinerators
CONTROL MEASURE Selective Non-Catalytic Reduction

DESCRIPTION

This control measure requires the use of add-on controls for small MWCs (>35 Mg/day and <225 Mg/day). The MACT standard for MWCs included a requirement for control of NO_x emissions to 190 ppmv (equivalent to SNCR control) for large existing facilities [>225 Mg/day (Pechan, 1994b)]. EPA decided not to set limits for small facilities. EPA estimated that the standard would affect 73% of the existing national capacity. For the purposes of this analysis, it is assumed that the source distribution within the five county area is the same as the national distribution, so that the proposed rule would affect 27% of the source category. Better estimates of costs and emission reductions could be made with information of the capacity by source within the inventory.

29. Municipal Waste Combustors: Require Application of Add-On Controls Equivalent to SNCR on Small MWCs

COST

Capital Cost

Not available.

Operating and Maintenance Cost

Not available.

Annualized Direct Costs

Not available.

Administrative Costs/Issues

Administrative costs will be incurred by both the air pollution agency and source if reporting and recordkeeping requirements are included in the rule. Reporting and recordkeeping requirements are recommended to assure compliance with the rule.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

Assumed to be the same as larger MWCs covered by the MACT standard - 45% (Pechan, 1994b).

Applicability - how many sources, their size

This control measure would apply to all small MWCs (>35Mg/day and <225 <Mg/day) in the five county region. No data were available to determine the number of sources that would fall within this size range.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

In 2005, 0.1 tpd of NO_x would be reduced.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be tracked via source reporting and recordkeeping requirements. The control measure could also require the use of continuous emissions monitoring (CEM) equipment and subsequent submittal of CEM data with the compliance reports. Costs for CEM requirements have not been included in the cost data presented here.

Availability

No availability issues.

COST-EFFECTIVENESS - Estimated to be $2,700/ton for the large sources covered by the MACT standard (Pechan, 1994b). For this assessment, it is assumed that the cost effectiveness for small MWCs will be as much as twice that of the larger facilities. Therefore a range of $2,700 to $5,400/ton is estimated.

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through reporting requirements and/or periodic inspections (especially if CEM are not required).

Ease of Determining Compliance

Compliance would be determined via review of source compliance reports.

Implementation Ease

No issues were identified.

Timing of Reductions

If the control measure was adopted by 1998, then 1999 would be the year to apply reductions, assuming the source is allowed one year to achieve compliance.

Publicly Acceptable

No issues were identified.

Politically Acceptable

Since EPA opted not to regulate these sources, establishment of control standards for the small MWCs will likely involve some political difficulties.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all small MWCs (as defined in the MACT standard). This excludes very small combustors (<35Mg/day). Application of SNCR is either not technologically feasible or cost effective for these sources. Larger sources are required to meet the requirements through the MACT standard.

Location

The requirement applies to all MWCs in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Ammonia slip emissions from the SNCR control will increase $PM_{2.5}$ emissions from the source, since the ammonia will combine with sulfate and nitrate either in the stack or ambient air to form a particulate ammonium salt. The control will also require a small amount of electricity to drive compressors and other electrical equipment which can be associated with emissions of various criteria pollutants, GHGs, and HAPs from the power generation source.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None identified.

Secondary Costs

Consumption of reducing reagent (e.g., ammonia or urea) and the energy required to produce these chemicals.

MEASURE NO. 31
SOURCE CATEGORY Highway Vehicle and Stationary Sources
CONTROL MEASURE Prem Air Catalysts

DESCRIPTION

Prem Air catalysts, under development at Englehard Corporation, represent an approach to air pollution control that focuses on destroying pollutants already in the air, rather than controlling emission sources. When coated with heat exchange surfaces, such as vehicle radiators and air conditioning condensers, Prem Air catalysts destroy pollutants in the air that pass over these surfaces. Prem Air catalysts represent a family of technologies to provide ozone destruction for mobile and stationary applications, and CO destruction for mobile applications.

Englehard demonstrated Prem Air catalysts in stationary applications during the summer of 1995. These early tests, in which Prem Air catalysts were applied to air conditioners, heat exchangers, and air-cooled condensers, show ozone conversion rates up to 85 percent. Test sites were refineries, utilities, and industrial facilities in California, Texas, and New Jersey. Durability studies are continuing, as are other technology development efforts.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost
Operating and Maintenance Cost
Annualized Direct Costs
Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels

Applicability - how many sources, their size

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Reduces ozone, not the purcursors.

Permanence

Measurable

Demonstrations of Prem Air catalysts on passenger cars in Los Angeles showed limited effectiveness as a result of NO_x scavenging. Results may change in other urban atmospheres.

Availability

Right now, this must be considered as an emerging technology, not a demonstrated one.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs

MEASURE NO. 33
SOURCE CATEGORY Asphalt Sealant
CONTROL MEASURE

DESCRIPTION

Asphalt sealants are used to restore and protect asphalt surfaces that have cured for at least 6 weeks. The South Coast Air Quality Management District (SCAQD) regulates asphalt sealants under their Architectural Coating Rules. This rule states that effective December 1, 1993, black traffic coatings must not contain more than 250 grams of VOC per liter of coating. These standards apply to manufacturers, importers and distributors who are responsible for complying with the rule. No current federal regulations concerning the VOC content of this source category exists. However, It appears that VOC content of asphalt sealants will be regulated under the proposed National Volatile Organic Compounds Emissions Standards for Architectural Coatings Rules.

The sealants manufactured for residential use consist of usually either an acrylic latex or a coal-tar/clay material. Neither product contains appreciable amounts of solvents and therefore the regulation of this product is expected to have no benefit to atmospheric VOC reductions.

The commercial version of this product category is sometimes applied hot. Current efforts are underway to determine the VOC content and emissions of these commercial products.

Criteria for Evaluating Ozone Control Measures (Revised 9/20)
COST
Capital Cost
Operating and Maintenance Cost
Annualized Direct Costs
Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels

MEASURE NO. 35
SOURCE CATEGORY Diesel Vehicles and Trucks
CONTROL MEASURE California Reformulated Diesel Fuel

DESCRIPTION

The California regulations limit motor vehicle diesel fuel sulfur content Statewide at 0.05 percent for all refiners and limit aromatic hydrocarbon content at 10 percent for large refiners and 20 percent for small refiners. The California S content limit is the same as the Federal requirement that was effective October 1, 1993. Thus, the emission benefits of California reformulated diesel would be the result of the lower aromatic hydrocarbon content of this fuel. Diesel fuel normally has about 30 percent aromatics.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost California estimated that the total capital investment by refiners in that State to meet the aromatic HC content restrictions would be $430 million for large refiners and $40 million for small refiners. Operating and Maintenance Cost Fuel price increases of 1 to 4 cents per gallon are estimated by the California Air Resources Board staff. Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Reduces motor vehicle diesel NO_x emissions 7 percent compared with diesel fuel meeting Federal requirements for sulfur content restrictions under Section 211 of the Clean Air Act.
Applicability - how many sources, their size All diesel-powered motor vehicles.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

0.8 tpd of NO_x reduced in 2005.

Permanence

Yes.

Measurable

Yes.

Availability

This fuel is currently being sold in California.

COST-EFFECTIVENESS - *cost/ton* for each precursor and for both precursors combined, over the lifetime of the control. For NO_x - \$3,700 to \$7,700 per ton reduced.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Compliance would have to be determined at fueling stations.

Implementation Ease

Difficult to implement successfully in a small geographic area because long haul truckers can purchase fuel outside the nonattainment area.

Timing of Reductions

Emission reductions occur as soon as the cleaner fuel is made available for sale.

Publicly Acceptable

When reformulated diesel fuel was introduced, refiners and marketers feared that the fuel might increase engine wear because of decreased fuel lubricity. In practice, many trucks experienced leaking o-rings and seals in the fuel system. Both EPA and the California Trucking Association believed that the lower aromatic California fuel was responsible, not the lower sulfur levels. The problem was further found to be isolated to older nitrile rubber components. Once these were replaced by fluorocarbon elastomer components, or newer nitrile rubber ones, the problem seemed to disappear. It is not known whether the newer nitrile rubber components will begin to leak over time.

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Truckers will incur higher diesel fuel costs.

Location

Regulations could be written to require California reform diesel sales in the five county area. However, it would be more effective to have a larger geographic area participate in this program to ensure that trucks operating in the five county area are fueled with the lower polluting diesel.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reduces particulate emissions by 25 percent and SO_2 emissions by 82 percent.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

PM emission reductions should lower PM ambient concentrations and improve visibility.

Secondary Costs

Trucks may have to replace seals to avoid leaks with the lower aromatic fuels.

MEASURE NO. 36
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE More Remote Sensing

DESCRIPTION

Remote sensing is a way to measure pollutant levels in a vehicle's exhaust while the vehicle is traveling down the roadway. Current RS systems measure hydrocarbons and CO in the exhaust system, and NO_x capability is being added. RS can be used to identify vehicles with malfunctioning emission controls between scheduled I/M tests. To take advantage of RSD's potential to identify dirty cars, EPA is requiring enhanced I/M programs to conduct supplemental emission measures on at least 0.5% of vehicles subject to I/M testing each year. Vehicles that fail the RS test would be required to be re-tested by the regular I/M test. Repairs would be required for any vehicle failing this out-of-schedule I/M emissions check.

Remote sensing could be used to monitor much more than 0.5% of the fleet. Pennsylvania is applying for extra credits for additional RS as part of its I/M SIP. Effectively, this means that the number of RS measurements each year in the five county area will increase from 20,000 to about 30,000.

Remote sensing could be used by I/M program areas to measure emissions from many more cars, given adequate resolution of the following issues: (1) placement of roadside monitors, (2) appropriate pass/fail levels, (3) notification, and (4) effects on driver behavior.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost
Operating and Maintenance Cost Contractor charges for performing remote sensing measurements and supplying license plate numbers and emission readings are in the range of 50 cents to one dollar per vehicle. Motorist costs for those who fail the RS test would include time for an additional inspection, plus repair costs.
Annualized Direct Costs
Administrative Costs/Issues The Commonwealth would have to process the data bases provided by the RS contractor and mail emission inspection notices to high emitters.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels

Applicability - how many sources, their size

Highway vehicles subject to emission inspections.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

1.2 tpd VOC and 0.6 tpd NO_x based on percentage reductions from the current decentralized I/M program in California.

Permanence

Measurable

There is no guidance yet from EPA on how to calculate emission credits from a remote sensing program other than the credits in MOBILE5a_H for adopting more than the minimum program.

Availability

Yes.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control: $3,340 per ton combined VOC plus NO_x.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

There may be problems if RS readings do not correlate with Acceleration Simulation Mode test results.

Implementation Ease

Timing of Reductions

Publicly Acceptable

It is unclear how motorists will react to (1) the presence of remote sensors at the roadway measurement site and (2) to letters requesting that they bring their car in for a between cycle emission inspection.

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. 37
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Scrappage Program

DESCRIPTION

On-road testing and emission models have shown that a small number of vehicles are responsible for a disproportionate amount of motor vehicle emissions. These dirty vehicles are generally older, with less sophisticated emission control equipment than recent model vehicles. One means of reducing the emissions effects of these vehicles is to remove them from service.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Funds have to be available to purchase high-emitting vehicles for about \$600 to \$700 per car. Operating and Maintenance Cost Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Applicability - how many sources, their size

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

A limited scope program could reduce VOC and NO_x emissions by 0.1 tpd each in 2005.

Permanence

Measurable

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control: $4,800 per ton for a California program.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.   Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs

MEASURE NO. 38
SOURCE CATEGORY Heavy-Duty Diesel Vehicles
CONTROL MEASURE Emissions Inspection Program

DESCRIPTION

The Clean Air Act does not require States to implement in-use, diesel smoke testing programs. However, a number of States that exceed the Federal ambient particulate and/or NO_x standards, or for other reasons, have opted to adopt diesel testing programs. Because it is not required, EPA does not provide program design guidance, as it does for basic and enhanced I/M programs. To fill the gap, the Society of Automotive Engineers (SAE), working in conjunction with the California Air Resources Board, has stepped in to formulate a recommended testing procedure for diesel-fueled vehicles.

SAE has recently completed its protocol for diesel smoke testing (SAE J1667). The procedure uses a snap acceleration opacity test. The meter must digitally filter out the high frequency smoke readings produced during snap acceleration, and have a standardized response time. The test is repeated three times. The cut points are adjusted for dry air density and barometric pressure, although they may vary from State-to-State. Below 1,500 feet, a 40 percent opacity cut point is common for post-1991 model year engines. It is believed that these cut points are indicative of the fact that an engine is operating close to its certification level.

Concurrently, the International Standards Organization (ISO) has formed a committee to develop procedures for nonroad diesel smoke testing (ISO-8178-9). It is likely that the committee will adopt parts of SAE J1667; specifically, the smoke meter specifications and analysis procedures. The standard is expected to be completed in 1997.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Capital costs to the Commonwealth will be minimal if existing weigh stations can be used for emission inspections. To do this, there has to be enough space to perform the emissions inspection in a lane separate from the weigh station lane. Operating and Maintenance Cost Repair costs for trucks that fail the snap idle test will average $650. In California, trucks that fail the smoke test pay a minimum penalty of $300. Annualized Direct Costs Administrative Costs/Issues Staff will have to be hired to administer the inspections.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

This program primarily targets PM emission reductions. Some analyses show that NO_x benefits may be 4 percent from baseline levels. However, recent data from California show potential NO_x disbenefits from the repairs made to solve excess smoke problems. California has estimated that first year benefits are a 1.1% VOC and a 1.6% PM emission reduction for diesel trucks with 8.5 percent of the fleet targeted for inspections. These benefits are estimated based on component failures, not emission measurements. If 100% of the fleet is targeted, the reduction in VOC and PM emissions is estimated to be 13% and 19%, respectively.

Applicability - how many sources, their size

Applies to heavy-duty diesel vehicles.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

Permanence

Benefits occur as long as the program is in-place.

Measurable

Because no standard protocols exist for estimating heavy-duty diesel I/M benefits, it would be necessary for the Commonwealth to reach agreement with EPA on appropriate techniques for estimating benefits.

Availability

Yes.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

IMPLEMENTABILITY

Enforcement

Enforcement effectively occurs through the inspection process.

Ease of Determining Compliance

Trucks that fail the smoke test have a defined time period to mail-in certification that repairs were made. Higher fines are paid if a truck fails the test twice within a year of the initial test.

Implementation Ease

Would require new staff and these staff would have to be trained in the test procedures. It also requires that space be available at existing weigh stations or other suitable test sites for large trucks. Urban buses can be self-inspected.

Timing of Reductions

Benefits would be observed shortly after program initiation.

Publicly Acceptable

There are currently 11 States that either have or expect to implement diesel-powered vehicle smoke I/M programs. New Jersey is currently running a pilot, roadside diesel testing program.

Politically Acceptable

Consensual

Voluntary

No.

Who Pays - Fairness

Heavy-duty diesel trucks.

Location

There are two semi-permanent weigh stations in the five county area that could be used for initial testing. One is in Delaware County at the Welcome Center on I-95. The other is at Yardley on I-95 southbound. These weigh stations are also used periodically for safety inspections.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Primary benefits are PM reductions.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Should improve visibility by reducing diesel PM.

Secondary Costs

MEASURE NO. 39
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Emissions-Based Registration Fees

DESCRIPTION

The operation of an emissions/vehicle miles traveled (VMT)-based registration fee policy requires that there be an enhanced I/M program in the area. Under the program, emission rates are measured each year, or every two years. Then, vehicle owners are charged a registration fee based on annual VMT times the vehicle emission rate. The emission rate could be VOC plus NO_x, or one of these pollutants alone.

A revenue neutral policy would be designed so that the average fee was equal to the existing Pennsylvania registration fee. This program achieves highway vehicle emission reductions by providing an incentive to retire vehicles earlier than natural scrappage would suggest, leading to a younger age mix across the vehicle fleet. This is the primary method of reducing emissions - since the program is revenue neutral, there is no change in the total driving cost, and VMT should not change.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost None
Operating and Maintenance Cost If a revenue neutral program is selected, registration fees would be higher for some vehicle owners than they are now, and lower for others.
Annualized Direct Costs
Administrative Costs/Issues A more complex calculation of vehicle registration fees may require more Department of Motor Vehicles staff time and cost.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels

Applicability - how many sources, their size

Highway vehicles - most likely to be those included in the emission inspection program (less than 9,000 lbs).

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Permanence

This measure's success depends on vehicle owner's responses to financial incentives to reduce emissions, so the amount of emissions that might be reduced is uncertain.

Measurable

Through analysis of enhanced I/M test results. The EPA-sponsored EFEE model can be used now to estimate emission benefits associated with different fee programs.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

IMPLEMENTABILITY

Enforcement

Self enforcing.

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Tied to I/M program implementation scheduled.

Publicly Acceptable

Would create a different registration fee schedule in the five county area than elsewhere in Pennsylvania.

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Highest costs are likely to be borne by lower income, older car owners.

Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc. Secondary Costs

MEASURE NO. 42a
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Emissions Reduction Credit for Heavy Duty Buses: Clean Diesel for Older Buses (Baseline)

DESCRIPTION

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost 0: Assumes planned replacement program extended through 2005. New emission standards for buses will automatically reduce emissions as the fleet is replaced. It is our understanding that this element was not specifically included in the CAA baseline (MOBILE5)
Operating and Maintenance Cost 0: Baseline for other SEPTA fleet measures.
Annualized Direct Costs 0
Administrative Costs/Issues 0
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC: 16.8%; NO_x: 19.4%
Applicability - how many sources, their size Total SEPTA diesel fleet = 1,340 vehicles; 400 planed for 1997, this scenario assumes replacement of 1,200 by 2005.
Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Per Day: VOC: .47; NO_x 2.19; Combined: 2.66
Permanence Benefits will decline somewhat as fleet ages; continued maintenance can help. Other measures such as catalysts and traps can ameliorate effects.

Measurable

Vehicles should be required to be certified by EPA; on-road testing can also be done randomly to ensure continued low levels.

Availability

Engines now required to meet minimum 1994 standards (on which this is based); industry is working to improve technology.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

No incremental cost assumed.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

On-road testing after purchase.

Implementation Ease

Standard to buy, no change in fueling, may have additional maintenance expense to ensure continued proper tuning, etc.

Timing of Reductions

Will be gradual, with scheduled replacement.

Publicly Acceptable

Still diesel-odor, etc., but improved.

Politically Acceptable

See above.

Consensual

Yes.

Voluntary

Yes.

Who Pays - Fairness SEPTA - no incremental cost of note. Location SEPTA service area.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Secondary Benefits - materials, agricultural, tourism, land use, etc. Secondary Costs

MEASURE NO. 42 b
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Emissions Reduction Credit for Heavy Duty Buses: CNG for School buses in Phil. area

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost: $21,400,000; assuming 2,000 out of 2,645 schoolbuses in Phil. area come into program (if required); slow fill stations at $102,000 each accomodating 60 vehicles each (per 1990 EPA report); incremental vehicle cost $9,000 per bus based on recent bids in California program. Amortized for 10 years at 8%; annual cost $3,189,231. Operating and Maintenance Cost: Differential increase of $.1625 fuel cost per mile, increase of $$.1033 maintenance cost per mile, decrease of $.02 parts cost; combined increased cost per mile $.37 (averaga of 3 test cases in California per "School Bus Program- Transition to Alternative Fuels", p. 6, by Colucci, et. al November 1995). Estimate 12,800 miles per bus per year (180 days * 71 miles- statewide average school bus miles per Pupil Transportation Office.) Annual incremental operating cost $6,293,333. Annualized Direct Costs: $9,482,564 Administrative Costs/Issues: Refueling stations assume 1 slow fill station per 60 buses. Schools with fewer than 60 buses may need individual stations or will have to consolidate- may add costs and miles. Slow fill stations are not suitable for intermediate day runs- may also need some fast-fill capabilities for buses with longer ranges.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC- 10.7% Nox- 20.5%

Applicability - how many sources, their size: 1987 school buses total 2,645, this assumes replacement of 2000 with CNG vehicles at Cal. Air Research Board (CARB) standards.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Per Day: VOC: -.30 NOx: -2.32 Combined: -2.62

Permanence

Benefits will decline somewhat as fleet ages; continued maintenance can help. Other measures such as catalysts and traps can ameliorate effects.

Measurable

Vehicles should be required to be certified by EPA; on-road testing can also be done randomly to ensure continued low levels.

Availability

Most experience to date in California- active program including research. Capital acquisition prices have come down over the first two phases of the programs; operating costs may also declineas technology improves.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the

lifetime of the control: 2005 amortized cost per day over 2005 benefit in tons. VOC: \$290,800 NOx: \$37,350 Combined: \$33,200
IMPLEMENTABILITY
Enforcement: Compliance through vehicle acquisition program; need to monitor ongoing maintenance.; ensure that retired vehicles are scrapped not passed on to churches, others. Ease of Determining Compliance On-road testing after purchase. Implementation Ease Need to build fueling stations; training for fuelers and mechanics, safety procedures; determine range of vehicles vs. routes; establish incentive programs for procurements and operation; establish grounds for exemption if mandatory program. Timing of Reductions: As fleets are replaced. Publicly Acceptable Will need to advise public regarding safety concerns of fuel with their children riding. Overall bus safety a key point in CA- many other safety enhancements to buses at same time.
Politically Acceptable See above.

Consensual:

Can wait for volunteers, with big enough incentives- assuming buses perform. May need to legislate to achieve forecast levels.

Voluntary: See above.

Who Pays - Fairness

State- Capital, School- operating- may be a problem unless operating cost differential can be reduced or eliminated- fuel efficiency, maintenance cost reductions, etc.

Location

Throughout Philadelphia ares.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc

MEASURE NO. 43
SOURCE CATEGORY All Vehicles
CONTROL MEASURE Smoking Vehicle Program

DESCRIPTION

This voluntary program allows the public to report motor vehicles, trucks, and buses that are seen with excess tailpipe smoke to the State or local air pollution control agency via a toll-free number. In response, the agency sends a letter to the registered owner asking that the vehicle be voluntarily repaired, and that a questionnaire be returned to the District. By forming a partnership with the public, the program aims to educate and involve the public in an air pollution control program, and to motivate owners of gross polluting vehicles to have them fixed. It also promotes personal responsibility for cleaning the air, which mirrors the message of other outreach programs.

Smoking vehicle programs have been implemented in other nonattainment areas. For example, the San Francisco Bay Area began their program in December 1992. In the first three years of operation, this program logged over 190,000 calls from the public. Other California cities with smoking vehicle programs include Sacramento, San Diego, Los Angeles, and Ventura County.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost
Operating and Maintenance Cost In the San Francisco program, the first year publicity budget was $125,000 to reach nine counties. The budget for subsequent years is $100,000. The overall budget for the Smoking Vehicle Program in 1995-1996 was $454,700.
Annualized Direct Costs
Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels The San Francisco area estimates a 0.3% reduction in VOC emissions from motor vehicles in 1994

Applicability - how many sources, their size

Highway vehicles.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

0.2 tpd VOC

Permanence

If vehicles are repaired, the emission reductions have the same permanence that they would if an emissions inspection had prompted the repair.

Measurable

Areas have estimated emission reductions associated with smoking vehicle programs, but to date no EPA protocol exists for computing these benefits, and no area has been granted any SIP credits for their programs.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control: $6,300 per ton of VOC.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness   Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Particulate emission reductions would also be achieved. Secondary Benefits - materials, agricultural, tourism, land use, etc.   Secondary Costs

MEASURE NO. 51
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Rail Headway Improvements: Based on planned improvements to Route 7 (Bucks County)- Adding 2 trips per day peak, 18 trips per day off-peak (going to half hour headways).

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost: To be determined Operating and Maintenance Cost: To be determined Annualized Direct Costs Administrative Costs/Issues:
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC: -0.06% Nox: -0.06%
Applicability - how many sources, their size- Anticipated change in: daily passenger trips 712 peak, 3,036 off-peak; vehicle trips 475 peak, 2,024 off-peak;

MEASURE NO. 51
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Rail Headway Improvements: Based on SEPTA's planned improvements to R 7 Rail service (Bucks County)- Adding 2 trips per day peak, 18 trips per day off-peak (going to half hour headways).

Criteria for Evaluating Ozone Control Measures (Revised 6/20)

COST

Capital Cost: $20,500,000- based on two new train sets (engine plus 6 cars per set) plus $500,000 for additional storage required at yard. Amortized for 25 years at 8%, annualized cost $1,920,400.

Operating and Maintenance Cost: $4,517,000. Adds 2,443 passenger car miles per day to the system, using 6 car trains in the peak and 3 car trains in the off-peak. Cost estimate based on variable cost per mile (cost associated with vehicle miles and hours, not track); using 1993 reported SEPTA cost per passenger car mile, assuming one-half of operating expense is variable with miles (per national averages).

Annualized Direct Costs: $6,437,400 based on above.

Administrative Costs/Issues: None assumed.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels
VOC: -0.06% Nox: -0.06%

Applicability - how many sources, their size- Anticipated change in:
daily passenger trips 712 peak, 3,036 off-peak;

vehicle trips 475 peak, 2,024 off-peak;

VMT 6,700 peak, 28,500 off-peak.

Emission Reductions by Pollutant-estimated reductions -
VOC only: -0.042, NO_x only -0.063, VOC and NO_x combined -0.105

Permanence - Particularly important during construction, but benefits of increased riders should continue indefinitely (impacted by fares/ alternatives available/ level and quality of service)

Measurable- Changes in ridership easy to monitor; changes in emissions less direct - will depend on mode split before and after change, and mode to train station

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

VOC: $510,900 Nox: $340,600 Combined: $204,400

IMPLEMENTABILITY

Enforcement- Not applicable

Ease of Determining Compliance- Not applicable

Implementation Ease: Vehicle acquisitions, additional storage for cars needed at station end, operating budget authority required.

Timing of Reductions: Concurrent with 95 construction

Publicly Acceptable- Generally, depending on impact on SEPTA budget / deficit

Politically Acceptable

See above

Consensual- Yes

Voluntary- Yes

Who Pays - Fairness

Rider and SEPTA (ultimately taxpayer for subsidized portion of trip)

Federal government typically provides major portion of most capital funding (new train acquisition)

Location:

Bucks County primarily- R 7 improvements

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc. Reduced roadway congestion, reduced fuel use Secondary Costs

MEASURE NO. 51a (NEW).
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE **Rail Headway Improvements: Academic Exercise**
Analysis: Adding 2 peak trains to selected lines with high ridership, decreasing the headways during the peak from 30 minutes to 15 minutes (less on some lines). Specifically add peak service to Wilmington, Airport, Norristown, Warminster, Elwyn.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost: $102,500,000 based on 10 new train sets (engine plus 6 cars per set) plus $500,000 for additional storage required at each yard. Amortized for 25 years at 8%, annualized cost $9,602,000. Note that actual procurements would probably be for multiple unit cars (MUs) that can be split into 2 or 3 car units for greater operating flexibility. This would increase the capital cost. Likewise, if the fleet were to expand by 60 vehicles, a new maintenance and/or operating facility would likely be required, as current facilities are at capacity. Operating and Maintenance Cost: $15,072,208. Adds 2,325,600 passenger car miles per year to the system, using 6 car trains in the peak. Cost estimate based on variable cost per mile (cost associated with vehicle miles and hours, not track); using 1993 reported SEPTA cost per passenger car mile, assuming one-half of operating expense is variable with miles (per national averages). Annualized Direct Costs: $ 24,674,300 based on above. Administrative Costs/Issues: None assumed.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC: -1.8 % Nox: - 1.4%
Applicability - how many sources, their size- Anticipated change in: daily passenger trips - 12,840

vehicle trips - 8,560

VMT - 101,600

Emission Reductions by Pollutant-estimated reductions - tons per day
VOC only: -.12, NO_x only -.15, VOC and NO_x combined -.27

Permanence - Benefits of increased riders should
continue indefinitely (impacted by fares/ alternatives available/ level and quality of service)

Measurable- Changes in ridership easy to monitor; changes in emissions less direct - will depend on mode split before and after change, and mode to train station

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

VOC: $691,700 Nox: $549,400 Combined: $306,200

IMPLEMENTABILITY

Enforcement- Not applicable

Ease of Determining Compliance- Not applicable

Implementation Ease: Vehicle acquisitions, additional storage for cars needed at station end, operating budget authority required. Very unlikely to implement due to operating budget constraints.

Timing of Reductions: Unlikely

Publicly Acceptable- Generally, depending on impact on SEPTA budget / deficit

Politically Acceptable

See above

Consensual- Yes

Voluntary- Yes

Who Pays - Fairness

Rider and SEPTA (ultimately taxpayer for subsidized portion of trip)

Federal government typically provides major portion of most capital funding (new train acquisition)

Location:

Bucks, Delaware and Montgomery Counties (rail lines to Wilmington, airport, Warminster, Norristown and Elwyn)

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Reduced congestion on roadways, reduced fuel use

Secondary Costs

VMT 6,700 peak, 28,500 off-peak.

Emission Reductions by Pollutant-estimated reductions -
VOC only: -0.042, NO_x only -0.063, VOC and NO_x combined -0.105

Permanence - Particularly important during construction, but benefits of increased riders should continue indefinitely (impacted by fares/ alternatives available/ level and quality of service)

Measurable- Changes in ridership easy to monitor; changes in emissions less direct - will depend on mode split before and after change, and mode to train station

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

VOC: $ Nox: $ Combined: $

IMPLEMENTABILITY

Enforcement- Not applicable

Ease of Determining Compliance- Not applicable

Implementation Ease: Vehicle acquisitions, additional storage for cars needed at station end, operating budget authority required.

Timing of Reductions: Concurrent with 95 construction

Publicly Acceptable- Generally, depending on impact on SEPTA budget / deficit

Politically Acceptable

See above

Consensual- Yes

Voluntary- Yes

MEASURE NO. 61, 62, 63, 64, 71, 72, and 73
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE: Mobility Alternatives Program: Comprehensive program to promote rideshare, telecommute, transit pass, bicycle alternatives, etc.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital: 0 Operating and Maintenance: $807,000 - annual budget for 1997. Does not include savings in time, vehicle depreciation, or fuel that will accrue from reduced congestion and reduced vehicle trips. Annualized Direct Costs: $807,000 Administrative Costs/Issues: None assumed.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC: -1.2 % Nox: - 0.9 %
Applicability - how many sources, their size- Anticipated change in:

vehicle trips 6,000 (remove 3,000 vehicles from road per MAP report of progress)

VMT reduction of 64,100 miles per day

Emission Reductions by Pollutant-estimated reductions -
VOC only: -0.082, NO_x only -0.096, VOC and NO_x combined - 0.178

Permanence - Likely to continue and expand as long as support program continues.

Measurable- Difficult- voluntary compliance form employers. Reporting also voluntary- results may be understated.

Availability- regionwide.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

VOC: $10,609,800 Nox: $9,062,500 Combined: $4,887,600

IMPLEMENTABILITY

Enforcement- Not applicable

Ease of Determining Compliance- Not applicable

Implementation Ease: Already in place. Voluntary program.

Timing of Reductions: Phased with marketing and expansion of program.

Publicly Acceptable- Highly acceptable.

Politically Acceptable

See above

Consensual- Yes

Voluntary- Yes

Who Pays - Fairness

Ultimately taxpayer, funded through multiple organizations, benefits accrue regionwide

Location:

Regionwide.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Reduced congestion on roadways, reduced fuel use

Secondary Costs

MEASURE NO. 70
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Parking Expansion at Rail Stations: Construction of Planned 4,539 New Parking Spaces at Rail Stations Throughout the Philadelphia Region

DESCRIPTION

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost $14,751,750 - based on 4,539 new spaces at an average of $3,250 per space. (SEPTA cost ranges from $3,000 to $3,500 per space, exclusive of land acquisition). Amortized over 10 years at 8%. Operating and Maintenance Cost: None assumed. Annualized Direct Costs: $2,198,400. Administrative Costs/Issues: None assumed.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC .04%; NO_x .04%.
Applicability - how many sources, their size Based on CMAQ methodology, assume 43,860 reduction in daily VMT, 3,720 increase in vehicle trips (change in mode split).
Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Per Day: VOC .027; NO_x .043; Combined: .07 Permanence Benefits continue, will increase if carpool rates to stations increase and if utilization increases. Measurable Lot usage can be monitored; estimates of reduced mileage can be based on census, surveys, etc. Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control: 2005 amortized cost per day over 2005 benefit in tons.
VOC: $274,150; NO_x: $169,950; Combined: $104,900

IMPLEMENTABILITY

Enforcement

Voluntary program, can be attractive alternative to driving downtown.

Ease of Determining Compliance: Not applicable.

Implementation Ease: Capital construction program - reduced funding may reduce program.

Timing of Reductions: Most lots due for completion in 1997, one in 1996.

Publicly Acceptable

Very. Good alternative to driving. Some lot locations may generate local traffic but should not be a problem.

Politically Acceptable

Yes. Environmentally perceived as "friendly."

Consensual

Yes.

Voluntary

Yes.

Who Pays - Fairness

State and Federal and SEPTA combine to pay for capital, maximum match 80 percent Federal (depending on funding availability). SEPTA responsible for operating cost. Ultimately riders and taxpayers pay.

Location

Throughout Philadelphia area - 4,539 spaces altogether.

Bucks Co - 1,930

Delaware - 440

Montgomery - 1,146

Philadelphia - 115, Chester - 908

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc.
Secondary Costs

MEASURE NO. 74
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE Removal of 50 Percent of Pre-1980 Vehicles

DESCRIPTION

The DVRPC/COMSIS report on transportation measures evaluated 1996 emission benefits of removing 50 percent of pre-1980 light-duty vehicles. This measure re-evaluates these benefits for 2005, when much fewer cars are pre-1980 model years.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost The cost used in the cost effectiveness calculation for this measure is $700 per vehicle purchased, plus the public administration fee of $50. Operating and Maintenance Cost Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels A 0.05 to 0.7 percent VOC reduction and 0.01 to 0.3 percent NO_x reduction are estimated. These relatively small emission decreases occur because only 1.2 percent of the light-duty fleet in SE Pennsylvania is expected to be 25 years old in 2005. The biggest emission reductions were estimated for the case where 25 year old cars are replaced with cars only distributed from 1 to 24 years old. Applicability - how many sources, their size Passenger cars that would be 25 years old, or older, in 2005. Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined VOC reductions are 0.03 to 0.44 tpd. NO_x reductions are 0.01 to 0.31 tpd.

Permanence This could either be a one-time reduction, or a continuing program. Measurable Availability
COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control
IMPLEMENTABILITY
Enforcement Ease of Determining Compliance Implementation Ease Timing of Reductions Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

Who Pays - Fairness

Rider and SEPTA (ultimately taxpayer for subsidized portion of trip)

Location:

Bucks County primarily- Route 7 improvements

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. 70
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE: Parking Expansion at Rail Stations: Construction of planned 4,539 new parking spaces at rail stations throughout the Philadelphia region.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost: to be determined Operating and Maintenance Cost: Not determined Annualized Direct Costs: Administrative Costs/Issues:
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC- .04% Nox- .04%.
Applicability - how many sources, their size: Based on CMAQ methodology, assume 43,860 reduction in daily VMT, 3,720 increase in vehicle trips (change in mode split).

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Per Day: VOC: -.027 NOx: .043 Combined: -.07

Permanence

Benefits continue, will increase if carpool rates to stations increase and if utilization increases.

Measurable

Lot usage can be monitored; estimates of reduced mileage can be based on census, surveys, etc.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control: 2005 amortized cost per day over 2005 benefit in tons.

VOC: to be determined N0x: to be determined Combined:

IMPLEMENTABILITY

Enforcement: Voluntary program, can be attractive alternative to driving downtown.

Ease of Determining Compliance: Not applicable

Implementation Ease: Capital construction program - reduced funding may reduce program.

Timing of Reductions: Most lots due for completion in 1997, one in 1998.

Publicly Acceptable: Very. Good alternative to driving. Some lot locations may generate local traffic but should not be a problem.

Politically Acceptable: Yes. Environmentally perceived as "friendly".

Consensual: Yes.

Voluntary: Yes.

Who Pays - Fairness

State and Fed and SEPTA combine to pay for capital, max. match 80% Federal (depending on funding availability). SEPTA responsible for operating cost. Ultimately riders and taxpayers pay.

Location

Throughout Philadelphia area- 4,539 spaces altogether.

Bucks Co - 1,930

Delaware - 440

Montgomery - 1,146

Philadelphia - 115, Chester - 908

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. 76
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE National Low Emission Vehicle Program

DESCRIPTION

On December 9, 1994, EPA announced its final determination that reduction of new motor vehicle emissions throughout the Northeast OTR is necessary to mitigate the effects of air pollution transport, and to bring nonattainment areas in the OTR into attainment (including maintenance) of the ozone NAAQS. Through this determination, EPA promulgated a rule under Sections 184 and 110 of the Clean Air Act that requires emission reductions from new motor vehicles in the OTR to be equivalent to the reductions that would be achieved by the OTC-LEV program.

States would be relieved of their obligations under this requirement if EPA were to find that all automakers had opted into a LEV equivalent new motor vehicle control requirement deemed acceptable to EPA through rulemaking. EPA believes that such a program, which would be far better than the OTC-LEV, could be agreed upon and adopted in the near future. Because neither EPA nor the States could mandate such a program, it can become effective only upon agreement of a variety of parties.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Auto manufacturers incur research and development expenses to improve emission control technologies.
Operating and Maintenance Cost
Annualized Direct Costs CARB and EPA currently estimate that vehicles meeting LEV standards will cost just below $100 more than a vehicle meeting Federal Tier 1 standards. Auto manufacturers have estimated LEV car costs to be as much as $600 or $700 per vehicle.
Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Relative to the 2005 CAA baseline, the NLEV program should reduce highway vehicle emissions by 17 percent for VOC and 16 percent for NO_x.

Applicability - how many sources, their size

This program affects light-duty vehicles and light-duty trucks.

Emission Reductions by Pollutant-estimated reductions in 2005 - VOC only, NO_x only, VOC and NO_x combined

11.5 tpd VOC, 13.5 tpd NO_x, 25 tpd VOC plus NO_x.

Permanence

Yes.

Measurable

Emission credits can be computed using MOBILE5a.

Availability

NLEV adoption is pending agreement by New York and Massachusetts to join this program. This may occur shortly after the November elections (in Massachusetts' case).

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control. The combined VOC plus NO_x cost effectiveness is $1,860 per ton.

IMPLEMENTABILITY

Enforcement

Enforcement mechanisms are expected to be the same as those used now for Federal Motor Vehicle Control Program.

Ease of Determining Compliance

EPA certifies vehicles to low emission vehicle emission standards and in-use through the recall program. State/local agencies are involved in determining in-use compliance via emissions inspection program in five county area.

Implementation Ease

Timing of Reductions

If the program begins with 1997 model year vehicles in the OTC States, benefits would begin almost immediately, but the full benefits of the NLEV program would not be observed until 2015 as vehicles that meet Federal standards are replaced by those meeting the TLEV and LEV standards.

Publicly Acceptable

Increases the price of new cars.

Politically Acceptable

Consensual

Voluntary

No.

Who Pays - Fairness

Increased costs to auto manufacturers are expected to be passed on to new car and light truck buyers.

Location

NLEV program would apply in all States except California.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reduces CO and some hazardous air pollutants such as benzene, formaldehyde, acetaldehyde, and 1,3-butadiene.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

Higher new car costs may deter some potential purchasers from replacing an older, higher emitting car, with one that meets the LEV standards.

MEASURE NO. 85
SOURCE CATEGORY Service Stations - Vehicle Refueling
CONTROL MEASURE Stage II to Region Outside Five County Area

DESCRIPTION

This measure was analyzed by evaluating the potential VOC emission reductions in four counties: Berks, Lancaster, Lehigh, and Northampton. Base year emissions in these counties are about 8.6 tons per day. The VMT-based growth factor for the Philadelphia area is 1.23 between 1990 and 2005. If this same growth factor is applied to the four counties of interest, and the effects on onboard VRS accounted for in a 2005 emission estimate, then baseline 2005 VOC emissions are:

$$(8.6\ tpd)\ (1.23)\ \frac{1.86\ g/gal}{3.92\ g/gal} = 5.0\ tons\ per\ day$$

The 2005 emission factor with Stage II and onboard VRS is 0.65 grams per gallon. Thus, a 65 percent reduction in 2005 VOC emissions could be achieved by requiring stage II in these four counties.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Capital costs to install Stage II have been estimated to range from as low as $5,500 to as high as $36,000 per station depending on the station size (gasoline sales volume) and whether single or multiple product dispensers are used.
Operating and Maintenance Cost
Annualized Direct Costs
Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels 65% from 2005 levels

Applicability - how many sources, their size

Stage II is typically applied to the largest volume service stations.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

3.3 tpd of VOC in 2005

Permanence

Yes.

Measurable

Yes.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control $900 per ton of VOC.

IMPLEMENTABILITY
Enforcement
Ease of Determining Compliance
Implementation Ease
Timing of Reductions Immediate, once the equipment is installed.
Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Service station owners.

Location

Evaluated for Berks, Lancaster, Lehigh, and Northampton Counties.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Reduces HAPs such as benzene.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. 91
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE High Occupancy Vehicle Lanes

DESCRIPTION

This measure evaluates the development of a network of high occupancy vehicle (HOV) lanes in Southeast Pennsylvania.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Construction costs to add new lanes to freeways are very high (controlled access HOV facilities). The cost of diamond lanes depends on whether new lanes are built, or existing lanes are taken out-of-service. Operating and Maintenance Cost Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels An analysis performed for the Washington, DC metro area showed that going from a modest HOV network to an extensive HOV network would reduce 2010 light-duty vehicle emissions by 0.86 percent for HC, and 1.24 percent for NO_x.
Applicability - how many sources, their size Highway vehicles - light-duty vehicles and trucks.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

0.6 tpd VOC and 1.3 tpd NO_x.

Permanence

Measurable

Through traffic volumes on HOV versus other lanes.

Availability

There are a number of potential problems associated with HOV lanes being added to the Philadelphia roadway network. In locations where HOV lanes might be feasible, buses would then compete with existing train lines. In addition, there may not be space to construct new lanes.

COST-EFFECTIVENESS - *cost/ton for each precursor and for both precursors combined, over the lifetime of the control*

IMPLEMENTABILITY

Enforcement

This is normally performed by State police.

Ease of Determining Compliance

Implementation Ease

With the current roadways in the Philadelphia area, there may not be space to build new HOV lanes within existing right-of-way.

Timing of Reductions These are long-term construction projects, so emission reductions are not achieved until the roadway configurations are modified. Publicly Acceptable Turning existing lanes into diamond HOV lanes has proved to be unpopular with the public in many cities.
Politically Acceptable Consensual Voluntary Who Pays - Fairness Location

SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc. Secondary Costs

MEASURE NO. 96
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE LNG- Pilot Programs at Service Stations

Criteria for Evaluating Ozone Control Measures (Revised 6/20)

COST

Capital Cost: $328,000,000-

Assumes 800 stations in Phil. area are equipped with fast-fill light duty CNG capabilities ($310,000 each station); plus 20,000 private vehicles are purchased (incremental difference $4,000 per car; approx. 1 percent of Phil. autos; # of stations assumes 25 vehicles per day compared to 100 vehicles per day at centralized fleet fueling center). Source: Fill station per EPA 1990 Special Report, Vol. 1, p. 15, Table 5, median value. Vehicle cost per "Alternative Fuel Light Duty Vehicles" NREL, May 1996, p. 22. Assume 12,500 miles per vehicle (low end of average use).

Operating and Maintenance Cost

Differential fuel cost per mile of $.017 per NREL May 1996 p.22 at 2,100 miles per month.

Annual savings $4,239,200. No additional operating cost assumed for fueling stations.

Annualized Direct Costs

$44,642,500

Administrative Costs/Issues: No costs assumed. The number of vehicles participating is a prime determinant of cost benefit: greater penetration, beyond 1 percent, and/or utilization of stations at greater than 25 vehicles per day will decrease costs and/or increase benefits.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

VOC: 3.0% Nox: 1.3%

Applicability - how many sources, their size

Approximately 1.9 million passenger vehicles in Phil. 5 co. region- some in fleets.

Emission Reductions by Pollutant-estimated reductions -
VOC only: -2.41, NO_x only -1.42, VOC and NO_x combined -3.83

Source: baseline levels per Phil. baseline - Summary Tabulations of Highway Vehicle VMT and Emissions Inventories and Forecast, for 5 county Philadelphia area, Section 1, p. 9 for LGV-calculated gm/mile. New levels per "Alternative Fuel Light Duty Vehicles- Summary of Results from the National Renewable Energy Laboratory's Vehicle Evaluation Data Collection Efforts", May 1996, Figure 12, p. 16.

Permanence

Continued maintenance and monitoring necessary to ensure continued benefit.

Measurable

On individual vehicles- will depend on market penetration

Availability

Vehicles are becoming more readily available in certain models. Conversions may also be made; but reliability and emissions benefit less certain than for OEM. Some tests of conversions have shown worse levels of emissions than for gasoline powered vehicles.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

Based on assumptions above:

VOC: $174,100 Nox: $294,300 Combined: $109,400

IMPLEMENTABILITY
Enforcement Assumed to be voluntary for vehicles; for stations- assumed voluntary with incentives.
Ease of Determining Compliance After procurement- through standard vehicle and station inspections
Implementation Ease Will require publicity for participating stations, lead time for establishing stations and training, vehicle market penetration efforts.
Timing of Reductions Will depend on timing of vehicle changes
Publicly Acceptable Once implemented should be fine; getting there may be difficult
Politically Acceptable Cost is an issue Consensual

Voluntary

Assumed voluntary for public

Who Pays - Fairness

Stations: primarily state? Vehicles- private with tax incentive?

Location:

Throughout Philadelphia region

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. 106
SOURCE CATEGORY Lawn and Garden
CONTROL MEASURE Incentives for Electric Lawnmowers

DESCRIPTION

Trade-in gasoline engine mowers for electric. Businesses can earn credits for offering rebates, discounts, or other incentives for homeowners to trade-in equipment.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Ryobi Mulchinator battery-powered mowers currently retail for around $335. Operating and Maintenance Cost Operating costs for a typical lawn have been estimated to be 8.5 cents per mowing for an electric mower compared with 31 cents for gasoline. Aside from sharpening the blade once per year (about $7), there are no maintenance costs for the electric mower. It is estimated that the gasoline mower would require $88 in servicing over the same period. Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Compared with a gasoline-powered mower meeting EPA's 1997 emission standards, a cordless mower has 99.9% lower VOC emissions, 95% lower NO_x emissions. Applicability - how many sources, their size

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Depends on the rate at which electrics replace gasoline-powered mowers.

Permanence

Measurable

Need to have a mechanism to account for electric lawnmower sales/gasoline mower replacements.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Would accrue over time as older, gasoline-powered mowers are replaced by electric mowers.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. Secondary Benefits - materials, agricultural, tourism, land use, etc. Noise reduction. Secondary Costs

MEASURE NO. 109
SOURCE CATEGORY Airport
CONTROL MEASURE California FIP Rule

DESCRIPTION

This control measure is based on the California FIP rule for airports and requires various measures to be implemented at airports to reduce emissions of both VOC and NO_x from aircraft, auxiliary power units, and ground support equipment (GSE). The proposed control measure relies on a bubble concept (cap program) for reducing emissions of VOC and NO_x. Commercial aircraft operators are required to achieve a series of declining targets. Control options are targeted for emissions from aircraft and ground support equipment, including auxiliary power units. The control measure will also include a trading component that will take advantage of the highly variable nature of factors affecting potential emission reduction options available to aircraft operators. This control measure does not include a transportation control component (i.e., for ground vehicle traffic).

For the proposed control measure, each commercial airline will be required to achieve an industry-wide series of declining emission rate targets. The emission rate targets are expressed as pounds of pollutant per passenger equivalent unit (lb/PEU). PEUs reflect both the actual number of passengers carried as well as the actual tonnage of cargo carried. If an airline achieves the ozone season emissions target, no further action is required. For airlines that do not meet the target, an emissions fee would be assessed. EPA set an initial fee of $10,000/ton in the California FIP rule (EEA, 1995).

Aircraft. Opportunities for controlling the emissions from aircraft are limited, primarily to operation practices. They generally target one phase of the landing and takeoff (LTO) cycle, which is the basis of the emission calculation methodology. The LTO cycle models the aircraft from airport approach, through landing and taxi in to the gate, then taxi out to the runway, takeoff, and climb out toward cruise altitude. The FIP considered the following specific measures:

- **Single/Reduced Engine Taxiing** - Since low thrust is needed to taxi an aircraft, one or more engines typically can be shutdown during taxi. By operating only one engine (or in some cases two), emissions during taxi and idle are cut substantially. The operating engine(s) operates at higher power than it would otherwise but this is at a somewhat more efficient point on its power curve. The other engines must be run for at least two minutes to achieve thermal stability prior to takeoff and to cool down prior to shutdown; however, most of the taxi/idle time would be with a single engine operating.

- **Reduce Airport Airside Congestion** - To reduce taxi time, there are several things that can be done to reduce congestion and to speed the time it takes an aircraft to taxi from the gate to the runway. These options are site specific but include constructing high speed turnouts to get aircraft off the runway faster, allowing intersection departure rather than requiring an aircraft to taxi to the end of the runway if they do not need the full runway length to takeoff, constructing additional runways and taxiways, and implementing procedures to coordinate aircraft so they do not have to form a queue while waiting for takeoff.

- **Reduce Takeoff Power** - Aircraft are designed to have adequate power to takeoff under extreme conditions such as very hot days when they are fully loaded with passengers, cargo, and fuel. When the conditions do not require full power, a derated takeoff procedure can be used to limit the engine thrust to the minimum necessary. By operating the engines at a lower power setting the NO_x emissions can be reduced.

- **Use Only Low-Emitting Aircraft** - Generally, engines on newer aircraft are cleaner than those on older aircraft. The FIP proposal encouraged the airlines to use only their newest aircraft for service into the California ozone nonattainment areas. This may be difficult to do in Philadelphia.

- **Set Technology-Forcing Engine NO_x Standards** - Lowering the aircraft engine NO_x emissions standard would lower the overall fleet emissions after sufficient new aircraft were added to the fleet. Because the average life of an aircraft is approximately 25 years, the fleet turnover is very low and this measure is useful only for meeting long-term goals.

- **Tow Aircraft to Runway** - Instead of taxiing, a departing aircraft can be towed from the terminal gate to the runway. The APU must be run while the aircraft is being towed to provide electricity and interior ventilation as well as compressed air to start the main engines away from the gate. Towing aircraft could substantially decrease the time the engines idle. There is a small tradeoff between aircraft engine exhaust emissions and emissions from the tow tractor and the aircraft's auxiliary power unit (APU); however, this could be a particularly effective measure, especially for wide-body aircraft.

- **Increase Load Factor** - By carrying more passengers per flight, fewer total LTOs are required. The average load factor for major airlines' domestic operations was 63% at the time of the FIP. Filling the 37% of the seats that were empty could allow the same travel demand to be met using many fewer aircraft with a commensurate reduction in emission.

<u>Ground Support Equipment</u>. Emissions from GSE are more amenable to control. Airports present excellent opportunities for GSE electrification:

- the vehicles operate within the limited confines of the airport boundary, which limits necessary range
- peaks of activity alternate with periods of little or no use, which allows for opportunity charging
- requirements of high speed operation are very limited

Conversion of GSE to alternative fuels also is feasible, with tests by airlines currently underway on the use of CNG and LNG.

COST
Capital Cost Some capital costs were available from a CARB study (EEA, 1994). Capital Costs for installation of Central Power Systems (including both air conditioning and power) ranged from \$2.05 MM/gate for a diesel-powered mobile system to \$4.01 MM/gate for a centralized system. Simple payback periods ranged from 1.49 to 2.73 years, respectively. For conversion of GSE to compressed natural gas (CNG) or liquefied petroleum gas (LPG) fueled systems, EEA (1994) estimated the average cost to be between \$2,000 and \$3,000 per unit. For new equipment, an estimated increase of 10-25% in cost was given for CNG/LPG-fueled over conventional fuel-powered equipment. Costs for electric equipment were estimated at 10-30% higher than conventional equipment, however this does not appear to include battery replacement which can add substantially to annualized costs.

Operating and Maintenance Cost

Energy costs for central power systems range from $326,000/gate-year for the diesel-powered mobile unit to $232,000/gate-year for the centralized electric system. No information on operating costs was given for switching to alternatively-fueled GSE, however it was mentioned that maintenance costs tend to be lower (EEA, 1994).

Annualized Direct Costs

Not available.

Administrative Costs/Issues

Not available.

EFFICIENCY

Control Efficiency - % reduction from uncontrolled levels

It is assumed that the control program would be designed to achieve the minimum levels described in the documentation for the California FIP rule (EEA, 1995). These levels are 25% for VOC and 35% for NO_x.

Applicability - how many sources, their size

The control measure is designed to cover large commercial airports. The only airport of this type in the five county region is the Philadelphia International Airport.

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

In 2005, tpd of 3.75 NO_x and 2.35 tpd of VOC will be reduced, assuming full implementation of a cap and trade program.

Permanence

Emission reductions are considered permanent.

Measurable

Emission reductions would be measured against a baseline set up during development of the program. The airlines would be responsible for preparing annual compliance reports which document emission reductions.

Availability

No availability issues.

COST-EFFECTIVENESS - Not available. Cost effectiveness is expected to be highly variable and dependent on the control options selected by each airline and the value of emission reduction credits.

IMPLEMENTABILITY

Enforcement

Enforcement would be implemented through annual compliance reports.

Ease of Determining Compliance

Compliance would be determined via review of source compliance reports.

Implementation Ease

No issues were identified.

Timing of Reductions

If the control measure was adopted by 1998 and fully-implemented by 2001, it could be designed to achieve the emission reductions cited above by 2005. Emission reductions between 2001 and 2005 would depend on the design of the program.

Publicly Acceptable

No issues were identified.

Politically Acceptable

No issues were identified.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover the only commercial airport in the five county area.

Location Philadelphia International Airport.
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc. This control measure will also reduce emissions of CO, GHGs, and HAPs. Secondary Benefits - materials, agricultural, tourism, land use, etc. Lower quantities of fuel will be consumed, assuming that off-site power generation sources are more efficient at supplying the electrical power needed by the aircraft and GSE. Secondary Costs None identified.

MEASURE NO. 111
SOURCE CATEGORY Compression Ignition Engines
CONTROL MEASURE Adopt California Phase II Standards

DESCRIPTION

This control measure calls for the adoption of California Phase II exhaust standards for diesel [compression ignition (CI)] engines that are >175 horsepower (HP).. Both California and Federal emission standards took effect on January 1, 1996 for new CI engines in the 175 - 750 HP size range (6.9 g/bhp-hr). California has also proposed Phase II standards (5.8 g/bhp-hr) that will begin taking effect January 1, 2001. Recent discussions with CARB staff have revealed that the Phase II exhaust standards are likely to be dropped, since EPA is currently working on its own set of standards (Roland, 1996).

NO_x emission reductions are estimated for the proposed CARB Phase II exhaust standards with the anticipation that the EPA standards will result in similar emission reductions that will take effect around the year 2001. *However, due to EPA's pending adoption of new standards for this engine category, it does not appear that the proposed control measure should be considered for future adoption. EPA expects to issue a Notice of Proposed Rulemaking (NPRM) to formally propose the new emission standards contained in the nonroad SOP in early 1997. EPA expects that the NPRM will cover all sizes of diesel-fueled nonroad engines, and those gasoline-fueled and propane-fueled nonroad engines above 25 horsepower (EPA, 1996b).*

COST
Capital Cost No cost data have been developed by CARB (Roland, 1996). Operating and Maintenance Cost Not available. Annualized Direct Costs Not available. Administrative Costs/Issues Not available.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Assuming that the proposed CARB standard (or one very close to it) of 5.8 g/bhp-hr was adopted and took effect in 2001, it was estimated that by 2005 an additional 1.6% NO_x reduction would be achieved (above those achieved by the 1996 Federal standard). This estimate was made by using EPA emission reduction estimates for the 1996 exhaust standards (EPA, 1994e) and the difference between the CA Phase II standard 5.8 g/bhp-hr and the 1996 standard [6.9 g/bhp-hr (CARB, 1996)].

Applicability - how many sources, their size

This measure would apply to all CI engines greater than or equal to 175 HP and less than 750 HP.

Emission Reductions by Pollutant- estimated reductions - VOC only, NO_x only, VOC and NO_x combined

In 2005, 0.76 tpd of NO_x will be reduced. This estimate was made by combining both the nonroad diesel combustion construction and industrial category emissions for 2005 and using the incremental emission reduction of 1.6% derived above. Additional and more substantial reductions would occur during the years following 2005, as additional equipment is replaced with new equipment that meets the Phase II standard.

Permanence

Emission reductions are permanent.

Measurable

Emission reductions could be quantified by tracking sales of equipment meeting the new standards.

Availability

No availability issues.

COST-EFFECTIVENESS - CARB had no cost effectiveness estimates available (Roland, 1996) .

IMPLEMENTABILITY

Enforcement

Due to the mobility of the equipment involved, unless the measure was adopted as State-wide measures for each State, difficulties would arise in enforcement. This is another reason for waiting on EPA's next phase of emission standards for this source category.

Ease of Determining Compliance

Due to the mobility of the equipment, it would be very difficult to determine compliance for a measure that only covered the five county area, and only slightly less difficult if each state was to adopt state exhaust standards.

Implementation Ease

Establishing new exhaust standards would be difficult and would require close work with manufacturers to establish appropriate limits.

Timing of Reductions

If the control measure was adopted by 1998, then 2001 would be the year to begin applying reductions, assuming that manufacturers were involved in the standard-setting process and were allowed two years to bring the compliant engines to market. Since it is likely that the standards would not go into effect until least 2001, this does not allow for much engine turnover (and emission reduction) to occur by 2005.

Publicly Acceptable

No issues were identified.

Politically Acceptable

Since EPA, CARB, and manufacturers are currently working on tighter national standards, there would likely be considerable opposition from industry on the adoption of a separate set of State or local standards.

Consensual

N/A.

Voluntary

N/A.

Who Pays - Fairness

The control measure is designed to cover all CI engines in the 175 - 750HP size range in the five county area.

Location

The requirement applies to all CI engines (175-750HP) in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

This control measure will likely produce reductions in emissions of CO, VOC, and PM, although no quantitative data were available.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None identified.

Secondary Costs

None identified.

MEASURE NO. 128
SOURCE CATEGORY Highway Vehicles and Non-road Gasoline
CONTROL MEASURE Expand Reformulated Gasoline to Counties North and West of Five County Area

DESCRIPTION

This measure examines expanding the required reformulated gasoline area to Berks, Lancaster, Lehigh, and Northampton counties.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost It is unknown whether refineries made the capital investment needed to phase II RFG requirements when they made plans to deliver phase I RFG to opt-in areas in Pennsylvania. Operating and Maintenance Cost Costs to motorists of phase II Federal reformulated gasoline are expected to be in the range of 6.0 to 8.6 cents per gallon compared with baseline gasoline. Annualized Direct Costs Motorists would pay $30-$43 more for gasoline per year. Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Highway vehicle VOC emissions would be reduced by about 26 percent in 2005 and highway vehicle NO_x emissions by about 6 percent with Federal RFG II. Non-road spark ignition engine emissions would be reduced by 3.3 percent. Applicability - how many sources, their size Affects emissions from gasoline-powered vehicles and engines.

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

	VOC		NO_x	
	Without RFG	With RFG	Without RFG	With RFG
Berks County	13.7	10.2	17.5	16.5
Lancaster County	17.7	13.0	21.7	20.4
Lehigh County	15.9	11.6	17.0	16.0
Northampton County	8.7	6.4	10.9	10.2
	55.9	41.2	67.1	63.1

Permanence

Measurable

MOBILE5a can be used to estimate emission benefits for VOC. An adjustment to MOBILE5a results is used to estimate NO_x benefits.

Availability

Yes.

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

About $5,000 per ton.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Could be determined by analyzing fuel samples at service stations. EPA would have enforcement responsibility if the Commonwealth opts-in these counties to Federal program.

Implementation Ease

Timing of Reductions

Publicly Acceptable

Some people may object to paying higher gasoline prices. There has been adverse publicity about potential health effects associated with self serve exposures to phase I reformulated gasoline.

Politically Acceptable

Consensual

Voluntary

No.

Who Pays - Fairness

Costs are incurred by petroleum refineries and motorists.

Location

Berks, Lancaster, Lehigh, and Northampton counties are evaluated here. Actual program implementation could be in more, or fewer, counties.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Benzene emissions would be lower.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Secondary Costs

MEASURE NO. XX
SOURCE CATEGORY Highway Vehicles
CONTROL MEASURE: Easy Pass program for toll plazas (original investigation to determine potential for HOV bypass of toll stations. After discussion of planned Easy Pass program with Steve Joachim, of Delaware River Port Authority, it appears that the Easy Pass program is likely to eliminate nearly all congestion at toll plazas, thereby reducing the HOV incentive of reduced time. There may be slight HOV benefit to be realized from a discounted toll for HOV, but would be difficult to enforce. Therefore this analysis focuses on the benefits to be realized from reduced idling at the toll plazas.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost: $ Not known: program will be implemented (cost not applicable?) Operating and Maintenance Cost: $ Not known Annualized Direct Costs: $ Administrative Costs/Issues: None assumed.
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels VOC: -1.9% Nox: Data not available

Applicability - how many sources, their size-

Four toll facilities, 46 toll plazas (Delaware River Port Authority only; may expand to other authorities in the future, e.g. Burlington Co. Bridge Commission); avg. 400 cars per hour per plaza during peak period (am only) per manual plaza; capacity 700 per hour with dedicated transponder; with 40% market share will virtually eliminate queueing at toll plazas.

Emission Reductions by Pollutant-estimated reductions -

VOC only: -.13 NO_x only not known VOC and NO_x combined - unknown

Permanence - once in place should continue indefinitely and possibly expand.

Measurable- Changes in avg. time in queue or cars per queue fairly easy to monitor

Availability: Transponders being distributed widely- free with assignment of cost to credit cards, otherwise $10 refundable deposit.

IMPLEMENTABILITY

Enforcement- Not applicable

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

VOC: data not available   Nox: data not available

Implementation Ease: Acquiring equipment now.

Timing of Reductions: Goal: install fully by September 1997

Publicly Acceptable- Very- time savings, ease of use very commendable.

Politically Acceptable- Yes.

Consensual- Yes

Voluntary- Yes

Who Pays - Fairness

The user of the service pays- very fair.

Location:

DRPA toll sites- Rt. 95

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

Decreased travel time on tollways

Secondary Costs

MEASURE NO. 100
SOURCE CATEGORY Area Sources
CONTROL MEASURE Area Source Business Credits for Alternative Fuel Vehicles

DESCRIPTION

This measure would be designed to allow small businesses (such as bakeries) to generate mobile source emission reduction credits instead of applying new controls to reduce either VOC or NO_x emissions. Credits could be produced by applying control technology earlier than required by existing regulations, or by the use of emission control equipment not otherwise required. Some possible uses of mobile source emission reduction credits include delaying compliance with rules, offsetting emissions from temporary sources, improving air quality in general, and using them as an alternative to controls otherwise required of sources.

California's mobile source emission reduction credit program contains specific guidelines for generation of credits using:

a. accelerated retirement of older vehicles;
b. purchase of low emission transit buses;
c. purchase of zero emission vehicles;
d. retrofit of light- and medium-duty vehicles;
e. retrofit of heavy-duty vehicles; and
f. purchase of new, reduced-emission heavy-duty vehicles.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost See table on the following page. Operating and Maintenance Cost Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Applicability - how many sources, their size

Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined

Number of Vehicles Needed to Generate 25 Tons per Year of Emission Reduction Credits in 1993

	Approximate Number of Vehicles Needed			
Emission Reduction Credit Program	ROG	NO_x	Approximate Cost	Expected Life of Credits
Accelerated Retirement of Old Cars[B]	440		$350,000	3 Years
		1,700	$1.3 Million	
Low-emission Transit Buses (Methanol M100)	NC[C]	50	$1.9 Million to $3.5 Million[A,D]	12 Years
Low-emission Transit Buses (CNG)	NC[C]	50	$400,000 to $2.2 Million[A,D]	12 Years
Electric Transit Buses	NC[C]	25	NC[E]	18 Years
Zero-emission Vehicles[G]	3,800	3,800	NC[F]	10 Years
Light- and Medium-Duty Retrofit[H]	4,200[H]	4,200[H]	NC[I]	10 Years[H]
Heavy-Duty Retrofit[J]	NC[K]	58	NC[I]	3 Years[J]

Permanence

Measurable

Credit guidelines and protocols have to be established to estimate emission reduction credits.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance
Implementation Ease
Timing of Reductions
Publicly Acceptable
Politically Acceptable
Consensual
Voluntary
Who Pays - Fairness
Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc.
Secondary Costs

MEASURE NO. 106
SOURCE CATEGORY Lawn and Garden
CONTROL MEASURE Incentives for Electric Lawnmowers

DESCRIPTION

Trade-in gasoline engine mowers for electric. Businesses can earn credits for offering rebates, discounts, or other incentives for homeowners to trade-in equipment.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Ryobi Mulchinator battery-powered mowers currently retail for around $335. Operating and Maintenance Cost Operating costs for a typical lawn have been estimated to be 8.5 cents per mowing for an electric mower compared with 31 cents for gasoline. Aside from sharpening the blade once per year (about $7), there are no maintenance costs for the electric mower. It is estimated that the gasoline mower would require $88 in servicing over the same period. Annualized Direct Costs The assumed cost difference between an electric and a gasoline lawnmower is $75. The annualized capital cost, per unit, is $10.65. Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels Compared with a gasoline-powered mower meeting EPA's 1997 emission standards, a cordless mower has 99.9% lower VOC emissions, 77% to 97% lower NO_x emissions. Applicability - how many sources, their size

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

Depends on the rate at which electrics replace gasoline-powered mowers.

Permanence

Measurable

Need to have a mechanism to account for electric lawnmower sales/gasoline mower replacements.

Availability

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

The cost when considering only VOC will be $1,172 per ton of VOC when considering only consumer equipment, and $98 per ton of VOC when considering all equipment. The cost when considering only NOx will be $62,453 per ton of NOx when considering only consumer equipment, and $6,759 per ton of NOx when considering all equipment.

IMPLEMENTABILITY

Enforcement

Ease of Determining Compliance

Implementation Ease

Timing of Reductions

Would accrue over time as older, gasoline-powered mowers are replaced by electric mowers.

Publicly Acceptable

Politically Acceptable

Consensual

Voluntary

Who Pays - Fairness

Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc. Noise reduction. Secondary Costs

Lawnmower Emissions									
2-Stroke									
		HC (g/hp-hr)	NOx (g/hp-hr)	Avg hp	hr/yr	HC (g/yr)	HC (tpy)	NOx (g/yr)	NOx (tpy)
Consumer WBM		208	0.29	3.5	23	16744.0	0.018	23.3	0.00003
Commercial WBM		208	0.29	4	368	306176.0	0.338	426.9	0.00047
4-Stroke									
		HC (g/hp-hr)	NOx (g/hp-hr)	Avg hp	hr/yr	HC (g/yr)	HC (tpy)	NOx (g/yr)	NOx (tpy)
Consumer WBM		37.7	2.02	3.5	23	3034.9	0.003	162.6	0.00018
Commercial WBM		37.7	2.02	4	368	55494.4	0.061	2973.4	0.00328
Electric									
		HC (g/hr)	NOx (g/hr)	hr/yr	HC (g/yr)	HC (tpy)	NOx (g/yr)	NOx (tpy)	
Consumer		0.018	0.25	23	0.4	0.0000	5.8	0.0000	
Commercial		0.018	0.25	368	6.6	0.0000	92.0	0.0001	
Lawnmower Distribution and Total Emissions									
	Consumer								
	hp-hr/yr	HC (g/hp-hr)	HC (kg/yr)	NOx (g/hp-hr)	NOx (kg/yr)				
2-stroke	88,099,200	208	18,324,634	0.29	25,549				
4-stroke	792,892,800	37.7	29,892,059	2.02	1,601,643				
	Commercial								
	hp-hr/yr	HC (g/hp-hr)	HC (kg/yr)	NOx (g/hp-hr)	NOx (kg/yr)				
2-stroke	127,180,800	208	26,453,606	0.29	36,882				
4-stroke	720,691,200	37.7	27,170,058	2.02	1,455,796				
Total Emissions									
	Consumer (HC)	**Commercial (HC)**		**Consumer (NOx)**	**Commercial (NOx)**				
2-Stroke	18,324,634	26,453,606		25,549	36,882				
4-Stroke	29,892,059	27,170,058		1,601,643	1,455,796				
Total	101,840,357			3,119,871					
Emission Reductions									
	HC (g/hr) gas	**NOx (g/hr) gas**	**HC % Red**	**NOx % Red**					
2-Stroke	789.44	1.10	99.998%	77.29%					
4-Stroke	140.93	7.55	99.987%	96.69%					

Gasoline vs Electric Lawnmower Emissions

Emission Percentages (using all mower types)					
	Consumer (HC)	**Commercial (HC)**		**Consumer (NOx)**	**Commercial (NOx)**
2-Stroke	18.0%	26.0%		0.8%	1.2%
4-Stroke	29.4%	26.7%		51.3%	46.7%
Emission Percentages (using only consumer types)					
	Consumer (HC)			Consumer (NOx)	
2-Stroke	38.0%			1.6%	
4-Stroke	62.0%			98.4%	
Cost Effectiveness (using all mower types)					
HC (t/yr/unit) Average		0.108		NOx (t/yr/unit) Average	0.002
Cost (yr/unit)		$10.65		Cost (yr/unit)	$10.65
Cost per ton of HC		$98		Cost per ton of NOx	$6,759
Cost Effectiveness (using only consumer types)					
HC (t/yr/unit) Average		0.009		NOx (t/yr/unit) Average	0.000
Cost (yr/unit)		$10.65		Cost (yr/unit)	$10.65
Cost per ton of HC		$1,172		Cost per ton of NOx	$62,453
References:					
Nonroad Engine and Vehicle Emission Study, Tables I-04 & I-05 (EPA, 1991)					
EPRI Journal, p18 (Mar/Apr 1996)					

MEASURE NO. 112
SOURCE CATEGORY Off-Highway Recreational Vehicles and Engines
CONTROL MEASURE Adopt CARB Emission Standards

DESCRIPTION

Off-highway recreational vehicles, or engines, are those two stroke or four stroke, gasoline, diesel, or alternate-fueled engines that are designed to be used in, but not limited to, use in the following applications: off-road motorcycles, all-terrain vehicles, golf carts, go-karts 25 horsepower and greater, and specialty vehicles. The California Air Resources Board has established emission standards for 1995 and later recreational vehicles and engines. Separate standards are established for (1) specialty vehicle engines, (2) specialty vehicle engines and go-karts, (3) off-road motorcycles and all-terrain vehicles, and (4) golf carts.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost <u>Off-Road Motorcycles and ATVs</u> For 4-stroke engines, the necessary technology and associated cost is estimated to be $25. Manufacturers will probably elect to replace their 2-stroke engines with 4-stroke engines. <u>Golf Carts</u> Costs are those to convert to electric golf carts at all courses in the nonattainment area. A capital cost of as much as $100,000 may be required for storage facilities and wiring for a typical fleet of 60 carts. <u>Specialty Vehicles</u> New vehicle costs depend on whether the engine is <25 horsepower or not. Costs of from $66 to $100 per engine are expected. Operating and Maintenance Cost Annualized Direct Costs Administrative Costs/Issues
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels CARB estimates that by 2010, Statewide emissions from this source category would be reduced by 81 percent for VOC. This would be partially offset by a 6 percent NO_x emissions increase. Emission reductions would be lower in 2005 because the fleet would not all have new engines by that year.

Applicability - how many sources, their size Emission Reductions by Pollutant-estimated reductions - VOC only, NO_x only, VOC and NO_x combined Estimated to be 0.3 tpd VOC in 2005 in the five county area. Permanence Measurable Availability
COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control For off-road motorcycles and ATVs, the cost effectiveness is $60 to $700 per ton of VOC reduced. For golf carts, the cost effectiveness is $680 per ton. Specialty vehicle costs per ton are estimated to be $360 to $540 per ton of VOC.
IMPLEMENTABILITY
Enforcement Ease of Determining Compliance Implementation Ease Timing of Reductions Reductions would increase with time after rule adoption as new engines replace old equipment. Publicly Acceptable

Politically Acceptable
Consensual
Voluntary
Who Pays - Fairness
Location
SECONDARY EFFECTS
Secondary Pollutant Benefits - CO, HAPS, etc.
Secondary Benefits - materials, agricultural, tourism, land use, etc.
Secondary Costs

MEASURE NO. 116
SOURCE CATEGORY Lawn & Garden Equipment
CONTROL MEASURE Ban on High Ozone Days

DESCRIPTION

This control measure involves banning the use of lawn and garden equipment on those days for which a high level of ozone is forecasted. In this manner, the VOC emissions for that day decrease (and to a lesser extent, NOx emissions), and the possibility of an ozone exceedance decreases. This ban can be done either on all lawn & garden equipment, or on a consumer-only basis (as opposed to commercial) lawn and garden equipment.

Criteria for Evaluating Ozone Control Measures (Revised 6/20)
COST
Capital Cost Their are no know costs for a consumer-only high ozone day ban. For a high ozone day ban which includes commercial entities, the cost can be measured in lost earning potential - but is difficult to quantify. Operating and Maintenance Cost There are no known additional operating and maintenance costs. Annualized Direct Costs There are no annualized direct costs. Administrative Costs/Issues Not Available
EFFICIENCY
Control Efficiency - % reduction from uncontrolled levels This measure is expected to have a control efficiency of 100%, with a rule effectiveness of 80%. This results in a VOC reduction of 37.2% for a consumer-only high ozone day ban and 80.0% for a full high ozone day ban. This also results in a NOx reduction of 55.7% for a consumer-only high ozone day ban and 80.0% for a full high ozone day ban.(EPA,1991)
Applicability - how many sources, their size The control measure is designed to cover Lawn & Garden Equipment. This category includes smaller equipment used by homeowners, as well as larger equipment used by commercial entities. In the Philadelphia five county region 2-stroke and 4-stroke Lawn & Garden Equipment accounted for 15.1 and 15.0 tons of VOC per day, respectively, in 2005. Additionally, they accounted for 0.08 and 1.25 tons of NOx per day, respectively, in 2005. (EPA,1991)

Emission Reductions by Pollutant-estimated reductions -
VOC only, NO_x only, VOC and NO_x combined

VOCs will be reduced by 11.20 tpd (3.71 tpd from 2-Stroke engines, and 7.49 tpd from 4-Stroke engines) for a consumer-only high ozone day ban and 24.05 tpd (12.04 tpd from 2-Stroke engines, and 12.01 tpd from 4-Stroke engines) for a full high ozone day ban.
NOx will be reduced by 0.73 tpd (0.01 tpd from 2-Stroke engines, and 0.72 tpd from 4-Stroke engines) for a consumer-only high ozone day ban and 1.05 tpd (0.07 tpd from 2-Stroke engines, and 0.98 tpd from 4-Stroke engines) for a full high ozone day ban.

Permanence

Emission reductions will be only temporary until the ban has been lifted. Total ozone season VOC emissions are not expected to change.

Measurable

The rule effectiveness would be the sole determinations of the effectiveness of this measure.

Availability

Not applicable

COST-EFFECTIVENESS - cost/ton for each precursor and for both precursors combined, over the lifetime of the control

Their are no know costs for a consumer-only high ozone day ban. For a high ozone day ban which includes commercial entities, the cost can be measured in lost earning potential - but is difficult to quantify.

IMPLEMENTABILITY

Enforcement

Enforcement would be the primary difficulty with this measure. Stricter enforcement would lead directly to a greater control effectiveness, but would be difficult due to the large number of users affected by this measure.

Ease of Determining Compliance

Compliance would be difficult to determine.

Implementation Ease

Implementation would be coordinated through the Ozone Action Day program.

Timing of Reductions

The reductions would be timed so as to occur on high ozone days

Publicly Acceptable

No issues were identified.

Politically Acceptable

No issues were identified.

Consensual

N/A

Voluntary

N/A

Who Pays - Fairness

This measure may raise cost slightly for all commercial lawn services.

Location

The requirement applies to all users of lawn and garden equipment in the five county region.

SECONDARY EFFECTS

Secondary Pollutant Benefits - CO, HAPS, etc.

None identified.

Secondary Benefits - materials, agricultural, tourism, land use, etc.

None identified.

Secondary Costs

None identified.

Determination of Number of Lawn & Garden Equipment Units for the Philadelphia Five County Region

Total Emissions					
		VOC			
	VOC (tpd)	**kg/season**			
2-Stroke	15.0513	1788408			
4-Stroke	15.0134	1783905			
		NOx			
	NOx (tpd)	**kg/season**			
2-Stroke	0.0830	9862			
4-Stroke	1.2285	145971			
Total Ozone Season (days)		131			
2-Stroke					
Percentage of Type	**Consumer**			**Commercial**	
	VOC %	NOx %		VOC %	NOx %
WBM	12.0%	4.3%		17.3%	6.2%
WB Misc L&G	0.6%	0.2%		0.9%	0.3%
HH Chain Saws	7.7%	6.4%		26.0%	42.1%
HH Trimmers/Brushcut	8.2%	7.1%		12.5%	15.5%
HH Blowers	2.1%	1.8%		0.7%	0.6%
HH Backpack Blowers	0.1%	0.1%		7.7%	9.5%
HH Hedgetrimmer	0.1%	0.1%		2.5%	3.1%
HH Cut-Off Saw				1.6%	2.6%
TOTAL	30.8%	19.9%		69.2%	80.1%
4-Stroke					
	Consumer			**Commercial**	
	VOC %	NOx %		VOC %	NOx %
WBM	31.8%	16.5%		28.9%	15.0%
Multi-Spindle WBM				4.3%	9.2%
Riding Mowers	3.9%	8.2%			
Lawn Tractors	14.7%	30.2%			
Garden Tractors	6.5%	15.1%			
Tillers	3.9%	2.0%		4.1%	2.1%
Misc L&G	1.6%	0.8%		0.4%	0.8%
TOTAL	62.3%	72.9%		37.7%	27.1%

Determination of Number of Lawn & Garden Equipment Units for the Philadelphia Five County Region

2-Stroke					
kg of Emissions	**Consumer**			**Commercial**	
	VOC (kg)	NOx (kg)		VOC (kg)	NOx (kg)
WBM	214537.1	423.1		309707.7	610.8
WB Misc L&G	10726.9	21.2		15485.4	30.5
HH Chain Saws	138358.4	630.5		465019.9	4154.4
HH Trimmers/Brushcut	147373.4	697.3		223402.4	1532.1
HH Blowers	37534.7	180.1		12965.9	62.2
HH Backpack Blowers	1078.8	7.4		137315.6	941.7
HH Hedgetrimmer	1470.9	7.0		44408.5	304.6
HH Cut-Off Saw				29022.9	259.3
TOTAL	551080.2	1966.5		1237328.2	7895.6
4-Stroke					
	Consumer			**Commercial**	
	VOC (kg)	NOx (kg)		VOC (kg)	NOx (kg)
WBM	566798.1	24139.4		515184.9	21941.3
Multi-Spindle WBM				77026.1	13364.1
Riding Mowers	69323.5	12027.7			
Lawn Tractors	262123.7	44057.5			
Garden Tractors	115742.4	22041.3			
Tillers	69637.7	2965.8		73374.3	3124.9
Misc L&G	28339.9	1207.0		6354.4	1102.5
TOTAL	1111965.3	106438.6		671939.8	39532.8
2-Stroke					
Horsepower-Hours	**Consumer**			**Commercial**	
	VOC (hp-hr)	NOx (hp-hr)		VOC (hp-hr)	NOx (hp-hr)
WBM	1031428.4	1458965.7		1488979.3	2106176.1
WB Misc L&G	51571.4	72948.3		74449.0	105308.8
HH Chain Saws	464289.9	656742.7		3059341.3	4327468.8
HH Trimmers/Brushcut	513496.1	726345.4		1128294.8	1595984.3
HH Blowers	132631.5	187608.6		45816.0	64807.2
HH Backpack Blowers	5448.6	7707.1		693513.1	980981.2
HH Hedgetrimmer	5125.2	7249.7		224285.3	317253.8
HH Cut-Off Saw				190939.9	270086.4
TOTAL	2203991.1	3117567.5		6905618.8	9768066.7
4-Stroke					
	Consumer			**Commercial**	
	VOC (hp-hr)	NOx (hp-hr)		VOC (hp-hr)	NOx (hp-hr)
WBM	15034433.2	11950205.6		13665382.9	10862008.1
Multi-Spindle WBM				8282381.2	6583298.3
Riding Mowers	7454143.1	5924968.4			
Lawn Tractors	27304553.4	21703181.1			
Garden Tractors	12056496.2	9583175.3			
Tillers	1847153.0	1468220.2		1946268.6	1547002.7
Misc L&G	751721.7	597510.3		683269.1	543100.4
TOTAL	64448500.7	51227260.8		24577301.8	19535409.5

Determination of Number of Lawn & Garden Equipment Units for the Philadelphia Five County Region

2-Stroke				
Average Horsepower	**Consumer**		**Commercial**	
and Hours/Year	Average hp	Hours/yr	Average hp	Hours/yr
WBM	3.5	23	4.0	368
WB Misc L&G	3.5	23	4.0	368
HH Chain Saws	1.5	7	4.1	405
HH Trimmers/Brushcut	0.7	10	1.9	170
HH Blowers	0.8	9	0.8	197
HH Backpack Blowers	3.0	12	3.0	293
HH Hedgetrimmer	0.7	7	1.9	75
HH Cut-Off Saw			4.1	113
4-Stroke				
	Consumer		**Commercial**	
	Average hp	Hours/yr	Average hp	Hours/yr
WBM	3.5	23	4.0	368
Multi-Spindle WBM			13.0	800
Riding Mowers	13.0	36		
Lawn Tractors	15.0	40		
Garden Tractors	15.0	53		
Tillers	5.0	18	6.0	72
Misc L&G	3.5	23	4.0	368
2-Stroke				
Number of Units	**Consumer**		**Commercial**	
	# of Units	# of Units	# of Units	# of Units
WBM	12813	18124	1012	1431
WB Misc L&G	641	906	51	72
HH Chain Saws	44218	62547	1842	2606
HH Trimmers/Brushcut	73357	103764	3493	4941
HH Blowers	18421	26057	291	411
HH Backpack Blowers	151	214	789	1116
HH Hedgetrimmer	1046	1480	1574	2226
HH Cut-Off Saw			412	583
TOTAL	**150,646**	**213,091**	**9,463**	**13,386**
4-Stroke				
	Consumer		**Commercial**	
	# of Units	# of Units	# of Units	# of Units
WBM	186763	148450	9284	7379
Multi-Spindle WBM			796	633
Riding Mowers	15928	12660		
Lawn Tractors	45508	36172		
Garden Tractors	15165	12054		
Tillers	20524	16314	4505	3581
Misc L&G	9338	7422	464	369
TOTAL	**293,226**	**233,072**	**15,049**	**11,962**
GRAND TOTAL	**443,872**	**446,163**	**24,513**	**25,348**

Determination of Number of Lawn & Garden Equipment Units for the Philadelphia Five County Region

2-Stroke					
Grams/Gallon	**Consumer**			**Commercial**	
	VOC (g/gallon)	NOx (g/gallon)		VOC (g/gallon)	NOx (g/gallon)
WBM	976.97	1.36		976.97	1.36
WB Misc L&G	976.97	1.36		976.97	1.36
HH Chain Saws	1399.70	4.51		713.94	4.51
HH Trimmers/Brushcut	1348.03	4.51		930.00	4.51
HH Blowers	1329.24	4.51		1329.24	4.51
HH Backpack Blowers	930.00	4.51		930.00	4.51
HH Hedgetrimmer	1348.03	4.51		930.00	4.51
HH Cut-Off Saw				713.94	4.51
4-Stroke					
	Consumer			**Commercial**	
	VOC (g/gallon)	NOx (g/gallon)		VOC (g/gallon)	NOx (g/gallon)
WBM	171.87	9.21		171.87	9.21
Multi-Spindle WBM				62.13	13.56
Riding Mowers	62.13	13.56			
Lawn Tractors	56.69	13.58			
Garden Tractors	56.69	13.58			
Tillers	171.87	9.21		171.87	9.21
Misc L&G	171.87	9.21		42.40	9.25
2-Stroke					
Gallons of Gasoline	**Consumer**			**Commercial**	
	Gallons of Gas	Gallons of Gas		Gallons of Gas	Gallons of Gas
WBM	219594	311103		317008	449111
WB Misc L&G	10980	15555		15850	22456
HH Chain Saws	98849	139794		651343	921146
HH Trimmers/Brushcut	109325	154610		240218	339722
HH Blowers	28238	39934		9754	13795
HH Backpack Blowers	1160	1641		147651	208812
HH Hedgetrimmer	1091	1543		47751	67531
HH Cut-Off Saw				40652	57491
TOTAL	**469,237**	**664,181**		**1,470,228**	**2,080,063**
4-Stroke					
	Consumer			**Commercial**	
	Gallons of Gas	Gallons of Gas		Gallons of Gas	Gallons of Gas
WBM	3297831	2621001		2997527	2382330
Multi-Spindle WBM				1239758	985553
Riding Mowers	1115782	886997			
Lawn Tractors	4623809	3244290			
Garden Tractors	2041672	1623071			
Tillers	405176	322020		426918	339299
Misc L&G	164892	131050		149868	119189
TOTAL	**11,649,161**	**8,828,429**		**4,814,070**	**3,826,370**

Determination of Number of Lawn & Garden Equipment Units for the Philadelphia Five County Region

2-Stroke					
Gallons/Unit-Year	**Consumer**			**Commercial**	
	Gal/Unit-Year	Gal/Unit-Year		Gal/Unit-Year	Gal/Unit-Year
WBM	17	17		313	314
WB Misc L&G	17	17		313	314
HH Chain Saws	2	2		354	353
HH Trimmers/Brushcut	1	1		69	69
HH Blowers	2	2		34	34
HH Backpack Blowers	8	8		187	187
HH Hedgetrimmer	1	1		30	30
HH Cut-Off Saw				99	99
4-Stroke					
	Consumer			**Commercial**	
	Gal/Unit-Year	Gal/Unit-Year		Gal/Unit-Year	Gal/Unit-Year
WBM	18	18		323	323
Multi-Spindle WBM				1557	1557
Riding Mowers	70	70			
Lawn Tractors	102	90			
Garden Tractors	135	135			
Tillers	20	20		95	95
Misc L&G	18	18		323	323

REFERENCES

Measure No.

1. California Air Resources Board, *Determination of Reasonably Available Control Technology and Best Available Retrofit Technology for Metal Container, Closure and Coil Coating Operations*, ARB Industrial Section, Criteria Pollutants Branch, Stationary Source Division, July 21, 1992.

California Air Resources Board, *Determination of Reasonably Available Control Technology for Metal Parts and Products Coating Operations*, ARB Industrial Section, Criteria Pollutants Branch, Stationary Source Division, December 10, 1992.

South Coast Air Quality Management District, *Rules and Regulations of the South Coast Air Quality Management District*, January 1993 (includes updated rules through 5/96).

Control of Volatile Organic Compound Emissions from Wood Furniture Manufacturing Operations, U.S. Environmental Protection Agency, Office of Air and Radiation/Office of Air Quality Planning and Standards, April 1996.

3. *Alternative Control Techniques Document: Automobile Refinishing*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, downloaded from the EPA TTN, file dated May 1994.

Volatile Organic Compound Emissions from Automobile Refinishing - Background Information for Proposed Standards, Draft, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, EPA-453/D-95-005a, August 1995.

A. Latif, South Coast Air Quality Management District, personal communication with S. Roe, E.H. Pechan & Associates, Inc., August 20, 1996.

South Coast Air Quality Management District, *Rules and Regulations of the South Coast Air Quality Management District*, January 1993 (includes updated rules through 5/96).

4. T. Liebel, South Coast Air Quality Management District, personal communication with S. Roe, E.H. Pechan & Associates, Inc., August 21, 1996.

South Coast Air Quality Management District, *1994 Air Quality Management Plan, Appendix IV-A, Section 1: Stationary Source Control Measures*, April 1994.

REFERENCES

Measure No.

South Coast Air Quality Management District, *Draft Staff Report for Proposed Rule 1171 - Solvent Cleaning Operations*, June 14, 1996.

5. K. Kununiak, Bay Area Air Quality Management District, personal communication with S. Roe, E.H. Pechan & Associates, Inc., September 12, 1996.

Sacramento Metropolitan Air Quality Management District, *Staff Report, Proposed Amendments to Rule 448, Gasoline Transfer into Stationary Storage Containers and Rule 449, Transfer of Gasoline into Vehicle Fuel Tanks*, January 3, 1995.

6. "Regulatory Impact Analysis for the Petroleum Refinery NESHAP," Revised Draft, prepared for U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, prepared by E.H. Pechan & Associates, Inc. and Mathtech, Inc., March 15, 1994.

E.H. Pechan & Associates, *Technical Support Document for the Control of Fugitive Volatile Organic Compound (VOC) Leaks at: Oil and Gas Production Facilities and Conveying Stations, Refineries, Chemical Plants, Bulk Plants, Bulk Terminals, and Gas Processing Plants*, prepared for U.S. Environmental Protection Agency, Region IX, March 3, 1994.

8. E.H. Pechan & Associates, *Analysis of Incremental Emission Reductions and Costs of VOC and NO_x Control Measures*, Draft Report, prepared for Ambient Standards Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1994.

9. *Alternative Control Techniques Document: Offset Lithographic Printing*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, EPA 453/R-94-054, June 1994.

South Coast Air Quality Management District, *Rules and Regulations of the South Coast Air Quality Management District*, January 1993 (includes updated rules through 5/96).

10. *Beyond VOC RACT CTG Requirements*, U.S. Environmental Protection Agency, Control Technology Center, EPA-453/R-95-010, April 1995.

Meeting the 15-Percent Rate-of-Progress Requirement Under the Clean Air Act: A Menu of Options, STAPPA/ALAPCO, September 1993.

REFERENCES

Measure No.

12. A. Pritchard, California Department of Pesticide Regulation, personal communication with S. Roe, E.H. Pechan & Associates, Inc., September 1996.

    South Coast Air Quality Management District, *1994 Air Quality Management Plan, Appendix IV-A, Section 1: Stationary Source Control Measures*, April 1994.

13. "Phase II NO_x Controls for the MARAMA and NESCAUM Regions," EPA-453/R-96-002, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, Northeast States for Coordinated Air Use Management, Mid-Atlantic Regional Air Management Association, November 1995.

14. *Alternative Control Techniques Document — NO_x Emissions from Industrial / Commercial / Institutional (ICI) Boilers*, (EPA-453/R-94-022), U.S. Environmental Protection Agency, Office of Air and Radiation, Research Triangle Park, NC, March 1994.

18. *Alternative Control Techniques Document: Control of NO_x Emissions from Glass Manufacturing (Second Draft)*, U.S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC, June 1994.

20. *Alternative Control Techniques Document — NO_x Emissions from Stationary Gas Turbines*, (EPA-453/R-93-007), U.S. Environmental Protection Agency, Office of Air and Radiation, Research Triangle Park, NC, January 1993.

22. *Alternative Control Techniques Document — NO_x Emissions from Stationary Reciprocating Internal Combustion Engines*, (EPA-453/R-93-032), U.S. Environmental Protection Agency, Office of Air and Radiation, Research Triangle Park, NC, July 1993.

23. *Alternative Control Techniques Document — NO_x Emissions From Process Heaters*, (EPA-453/R-93-015), U.S. Environmental Protection Agency, Office of Air and Radiation, Research Triangle Park, NC, February 1993.

24. *Alternative Control Techniques Document: Control of NO_x Emissions from Iron and Steel Mills*, U.S. Environmental Protection Agency, Office of Air and Radiation and Office of Air Quality Planning and Standards, 453/R-94-065, September 1994.

REFERENCES

Measure No.

26. E.H. Pechan & Associates, *Technical Support Document for the Development of Draft Federal Implementation Plan (FIP) Rules for Stationary Sources of Nitrogen Oxide Emissions in the Sacramento, California Ozone Nonattainment Area*, Draft, prepared for U.S. Environmental Protection Agency, Region IX, April 30, 1993.

South Coast Air Quality Management District, *1994 Air Quality Management Plan, Appendix IV-A, Section 1: Stationary Source Control Measures*, April 1994.

27. South Coast Air Quality Management District, *Rules and Regulations of the South Coast Air Quality Management District*, January 1993 (includes updated rules through 5/96).

South Coast Air Quality Management District, *1994 Air Quality Management Plan, Appendix IV-A, Section 1: Stationary Source Control Measures*, April 1994.

28. E.H. Pechan & Associates, *Analysis of Incremental Emission Reductions and Costs of VOC and NO_x Control Measures*, Draft Report, prepared for Ambient Standards Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1994.

29. E.H. Pechan & Associates, *Analysis of Incremental Emission Reductions and Costs of VOC and NO_x Control Measures*, Draft Report, prepared for Ambient Standards Branch, U.S. Environmental Protection Agency, Research Triangle Park, NC, September 1994.

31. "Prem Air Clean Air System from Engelhard," Briefing Package provided by Engelhard Corporation, September 12, 1996.

34. "Transportation-Related Land Use Strategies to Minimize Motor Vehicle Emissions- an Indirect Source Research Study," California Air Resources Board.

Silver Spring Transportation System Management District Annual Report FY 1995, March 1996 (Montgomery County, Maryland).

1995 Commute Trip Reduction Results in King County, Fotini Georgiadou, February 1996 (Washington State); plus an unpublished paper from same source

REFERENCES

Measure No.

35. "Transmittal of the Philadelphia 5-County Area 1996 Emissions Inventory," memorandum from Bob Kaiser, COMSIS Corporation, to Wick Havens, Chief, Air Resource Management, Pennsylvania Department of Environmental Protection, July 3, 1996.

"Controlling Particulate Matter Under the Clean Air Act: A Menu of Options," State and Territorial Air Pollution Program Administrators, Association of Local Air Pollution Control Officials, July 1996.

36. "Evaluation of the California Pilot Inspection/Maintenance (I/M) Program," de la Torre Klausmeier Consulting, Inc. and Radian Corporation, prepared for California Bureau of Automotive Repair, Sacramento, CA, March 31, 1995.

37. "Retiring Old Cars - Programs to Save Gasoline and Reduce Emissions," Congress of the United States, Office of Technology Assessment, OTA-E-536 (Washington, DC: U.S. Government Printing Office, July 1992).

"Feasibility of Emission Credit Generation through the Accelerated Retirement of Older Vehicles (Draft)," State of California, California Environmental Protection Agency, Air Resources Board, July 1992.

Robert W. Hahn, "An Economic Analysis of Scrappage," American Enterprise Institute, Washington, DC, November 1994.

Robert G. Dulla, "Analysis of a Vehicle Scrappage Program in Fairbanks, Alaska," Sierra Research, memorandum to Michael Lidgard, U.S. Environmental Protection Agency - Region X, April 30, 1993.

38. "Controlling Particulate Matter Under the Clean Air Act: A Menu of Options," STAPPA/ALAPCO, July 1996.

Paul E. Jacobs, Donald J. Chernich, and John D. Kowalski, "California's Heavy-Duty Vehicle Smoke and Tampering Inspection Program," Society of Automotive Engineers Paper No. 911669, Future Transportation Technology Conference and Exposition, Portland, Oregon, August 5-7, 1991.

"Smoke Inspection Program for Heavy-Duty On-Highway Diesel Vehicles," Engine Manufacturers Association, Chicago, IL, September 18, 1991.

California Air Resources Board, "Heavy-Duty Vehicle Inspection Program (HDVIP)," Final Regulations, California Code of Regulations, Title 13, Subchapter 3.5.

REFERENCES

Measure No.

Christopher S. Weaver and Robert F. Klausmeier, "Heavy-Duty Diesel Vehicle Inspection and Maintenance Study," Radian Corporation, Sacramento, CA, submitted to California Air Resources Board, May 16, 1988.

"Determination of Benefits from the Heavy-Duty Vehicle Inspection and Maintenance Program," California Air Resources Board, El Monte, CA, September 1996.

39. "Highway Vehicle Emission Fees: Summary of Policy Considerations and Analysis of Selected Implementation Scenarios," Energy and Environmental Analysis, Inc., Arlington, VA, prepared for U.S. Environmental Protection Agency, Office of Policy Planning and Evaluation, Washington, DC, September 1994.

Dan Meszler and K.G. Duleep, "The EFEE Motor Vehicle Emissions Fee Model," EEA, Inc., Presented at The Emission Inventory: Key to Planning, Permits, Compliance and Reporting, Air & Waste Management Association, New Orleans, LA, September 5, 1996.

41. Jeff Long, California Air Resources Board, (818) 450-6140.

42a. Bus emissions spreadsheet- baseline value "SEPTAEMT.XLS."

SEPTA Fleet Inventory and Long Range Capital Plan.

42b. "School Bus Program: Transition to Alternative Fuels," November 20, 1995.

EPA Special Report Vol. I "Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel," April 1990, p. 4-9.

Conversation with Albert Deterville, Manager of California School Bus Demonstration Program.

43. Teresa Galvin Lee, Lucia Libretti, and Cindy Lou Winslow, "The Smoking Vehicle Program - A Voluntary Approach to Repairing High Emission Vehicles," 96-TA45.04, Air & Waste Management Association 1994 Annual Meeting Paper, June 1996.

44. "Transportation Control Measures - An Analysis of Potential Transportation Control Measures for Implementation in the Pennsylvania Portion of the DVRPC Region," Delaware Valley Regional Planning Commission, Philadelphia, PA, May 1994.

REFERENCES

Measure No.	
51.	Mick Wilke, SEPTA, (215) 580-7904.
	CMAQ Methodology.
55.	Wendy Stern, SEPTA.
	CMAQ Methodology.
61., 62., 63., 64.,	CMAQ Methodology.
71., 72., 73. (combined measures)	Mobility Alternatives Program Proposed FY 1997 Budgets, Delaware Valley Regional Planning Commission (DVRPC) - Office of Commuter Services.
	Participant information: Stacy Bartels: (215) 592-1800.
70.	Wendy Stern, SEPTA.
	CMAQ Methodology.
75.	Steven D. Burch, Matthew A. Keyser, Chris P. Colucci, Thomas F. Potter, and David K. Benson, "Applications and Benefits of Catalytic Converter Thermal Management," SAE Paper 961134, Warrendale, PA, 1996.
	"Emission Control System Upgrades for Gasoline-Powered, Light-Duty Vehicles: An Available Option for Reducing VOC and NO_x Emissions," Manufacturers of Emission Controls Association, Washington, DC, August 1996.
76.	"Analysis of Costs and Benefits of a National Low Emission Vehicle Program," E.H. Pechan & Associates, Inc., Springfield, VA, prepared for Vehicle Programs and Compliance Division, U.S. Environmental Protection Agency, Washington, DC, July 1996.
81.	"Alternative Fuel Transit Bus Evaluation," (Chandler/Malcosky et al.), May 1996, p.73.
	"Alternative Fuel Transit Buses," May 1995, Tables 3, 6, 8.
	Conversation with Gary Farrell, Cummins.
	"Alternative Fuel Buses," SEPTA FY 1997-2008 Capital Budget and Program excerpt.

REFERENCES

Measure No.

84. Susan DiDomenico, DVRPC.

85. "Technical Guidance - Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities - Volume I: Chapters," U.S. Environmental Protection Agency, EPA-450/3-91-022a, November 1991.

91. A. Planned implementation of transponder technology to reduce idling time at toll stations.

Delaware River Port Authority, Tony Lamurri - Manager, Applications Development & Support.

Delaware River Port Authority, Steve Joachim - Director, Technology & MIS, (609) 968-2012.

COMSIS - New Jersey Transit Evaluation.

CMAQ Methodology.

B. Analysis of HOV lane construction costs.

"Atlanta Express Lanes - Market Strategies & Potential Utilization," 8th International HOV Conference, Pittsburgh, PA, August 26-28, 1996, Gary Erenrich, COMSIS Corporation.

The Virginian-Pilot, September 27, 1995.

I-287/Cross Westchester Expressway: Design Report/Draft Environmental Impact Statement, USDOT, FHWAY, NYDOT, John B. Daly, May 1995.

96. "Alternative Fuel Light Duty Vehicles," Summary of Results from the National Renewable Energy Laboratory's Vehicle Evaluation Data Collection Efforts, May 1996, Figure 12, p. 16.

"Summary Tabulations of Highway Vehicle VMT and Emissions Inventories and Forecast," Philadelphia 5 county region, Sec. 1, p. 9.

"Alternative Fuels Overview," Sunoco handout to Stakeholders.

"Clean Fleet," Final Report, Executive Summary, Battelle.

REFERENCES

Measure No.	
	"Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: A 2000/2010 Analysis," U.S. Department of Energy, January 1996, p. C-39.
	EPA Special Report Vol. 1, "Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Passenger Cars and Light Trucks," April 1990, p. 15, Table 5.
	EPA Special Report Vol. 2, "Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Heavy-Duty Vehicles," April 1990, p. 4-16, Table 4-6.
98.	"Alternative Fuel Transit Buses," May 1995, p. 21, Table 8.
99.	EPA Special Report Vol. 1, "Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Passenger Cars and Light Trucks," April 1990, p. 15, Table 5.
	"Summary Tabulations of Highway Vehicle VMT and Emissions Inventories and Forecast," Philadelphia 5 county region, Sec. 1, p. 9.
	"Alternative Fuel Light Duty Vehicles," Summary of Results from the National Renewable Energy Laboratory's Vehicle Evaluation Data Collection Efforts, May 1996, Figure 12, p. 16, 22.
	EPA Special Report Vol. 2, "Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Heavy-Duty Vehicles," April 1990, p. 4-16, Table 4-6.
	"Mobile Source Emission Reduction Credits: Guidelines for the Generation and Use of Mobile Source Emission Reduction Credits," California Environmental Protection Agency, Air Resources Board, February 1996.
105.	"Cash-for-Clippers - A Lawn Mower Rebate and Trade-In Program," The Air Quality Planning Program, Maryland Department of the Environment, Baltimore, MD, September 12, 1996.
	"Nonroad Engine and Vehicle Emission Study - Appendices," (21A-2001), U.S. Environmental Protection Agency, Office of Air and Radiation, Washington, DC, November 1991.

REFERENCES

Measure No.

"The Environmental and Energy Benefits of Cordless Electric Lawn Mowers," EPRI Report TR106559, Electric Power Research Institute, Palo Alto, CA, July 1996.

"Proposed General Protocol for Determination of NO_x Reduction Credits Created from Switching from Gasoline to Electric Powered Lawn Mowers," Public Service Electric & Gas, prepared for Northeast States for Coordinated Air Use Management, September 22, 1993.

106. "Proposed General Protocol for Determination of NO_x Reduction Credits Created from Switching from Gasoline to Electric Powered Lawn Mowers," Public Service Electric & Gas, prepared for Northeast States for Coordinated Air Use Management, September 22, 1993.

109. Energy and Environmental Analysis, Inc., *Technical Support Document: Aircraft/Airports California FIP IFR, Draft*, prepared for U.S. Environmental Protection Agency, Motor Vehicle Emission Laboratory, February 9, 1995.

Robert Molle, Philadelphia International Airport, response to request for information including vehicle classification counts from December 1992.

"Alternative Fuel Transit Buses," U.S. Department of Energy, May 1995.

"Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: A 2000/2010 Analysis," U.S. Department of Energy, January 1996, p. C-39.

"EPA Special Report: Analysis of the Economic and Environmental Effects of Compressed Natural Gas as a Vehicle Fuel - Volume II Heavy Duty Vehicles," EPA, April 1990.

109B. Robert Molle, Philadelphia International Airport, response to request for information including vehicle classification counts from December 1992.

Sunoco handout to Stakeholders.

"Clean Fleet," Final Report, Executive Summary, Battelle.

"Assessment of Costs and Benefits of Flexible and Alternative Fuel Use in the U.S. Transportation Sector, Technical Report 14: Market Potential and Impacts of Alternative Fuel Use in Light-Duty Vehicles: A 2000/2010 Analysis," U.S. Department of Energy, January 1996, p. C-39.

REFERENCES

Measure No.

111. California Air Resources Board, "Notice of Public Meeting to Consider the Approval of Guidelines for the Generation of Mobile Source Emission Reduction Credits Through the Conversion of Off-Road Diesel Cycle Engines at or Above 50 Horsepower to Low-Emission Configurations," Mail-Out #96-11, April 25, 1996.

P. Lorang, U.S. Environmental Protection Agency, Office of Mobile Sources, Memorandum: "Future Nonroad Emission Reduction Credits for Court-Ordered Nonroad Standards," to U.S. Environmental Protection Agency Regional Directors, November 17, 1994.

"EPA Environmental Fact Sheet: Control of Emissions From Nonroad Engines," U.S. Environmental Protection Agency, Office of Mobile Sources, EPA420-F-96-009, July 1996.

S. Roland, California Air Resources Board, personal communication with S. Roe, E.H. Pechan & Associates, Inc., September 1996.

112. Notice of Public Hearing to Consider the Adoption of Emission Control Regulations for Off-Highway Recreational Vehicles and Engines, California Air Resources Board, Mail Out #93-54, January 1994.

122., 123, 124. (combined measures) A nationwide EPA study is underway to review periodic measures and establish guidelines for inclusion in conformity plans. The data are not ready for release, but Sacramento was identified as an agency with comprehensive data.

"The Cleaner Air Partnership 1995 Public Opinion Survey on Air Quality and Transportation," Sacramento, CA.

"A Time to Clean Up the Air: The Clean Air Partnership's Public Education Plan on Air Quality and Transportation," December 1994, Sacramento, CA.

128. "U.S. Petroleum Refining: Meeting Requirements for Cleaner Fuels and Refineries, Vol. I - Analyses and Results," National Petroleum Council, August 1993.

U.S. Environmental Protection Agency, Office of Mobile Sources, February 16, 1994, "Regulation of Fuels and Fuel Additives: Standards for Reformulated Gasoline," Final Rule (59 Federal Register 13416).

REFERENCES

Measure No.

Ozone Transport Assessment Group, "Mobile Sources Assessment: NO_x and VOC Reduction Technologies for Consideration by the Ozone Transport Assessment Group," Revised Final Report, Prepared by the OTAG Control Technologies & Options Workgroup, Mobile Sources Committee, April 11, 1996.

129. John McGee, SEPTA.

Nancy Core, Cincinnati METRO.

131. "Facts About Refueling Your Lawn and Garden Equipment," Maryland Department of the Environment, Baltimore, MD, 1996.

Sure Pour Automatic Leakless Nozzle Brochure, VEMCO, Inc., Emmett, ID, 1996.

"Report of the Initial Evaluation of the Sure Power Fuel Container Spout," VEMCO, Inc., Emmett, ID, Henry J. Beaulieu, Industrial Hygiene Resources, Ltd., Boise, ID.